R AND RELATED LAND RESOURCES

OF

CENTRAL REGION, MASSACHUSETTS

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
ECONOMICS, STATISTICS AND
COOPERATIVES SERVICE
FOREST SERVICE

IN COOPERATION WITH

MASSACHUSETTS WATER
RESOURCES COMMISSION

AUGUST 1978

The United States Department of Agriculture, in cooperation with the Massachusetts Water Resources Commission, is participating in a study of the water and related land resources within the Commonwealth. This report presents the results of that study in the Central Region which consists of the Merrimack, SuAsCo, Nashua, Blackstone, and Thames Study Areas.

The report was prepared by the Soil Conservation Service; Economics, Statistics, and Cooperatives Service; and Forest Service for use by the Massachusetts Water Resources Commission in the preparation of a comprehensive plan for the Commonwealth's water and land resources. The information and data will also assist local, state, and federal agencies in their specific planning activities for the coordinated and orderly conservation, development, utilization, and management of the water and land resources of Massachusetts.

The objectives of this report are to identify problems, needs, and alternative solutions in the following major resource areas: land use, flooding, erosion, sediment, and wetlands.

Acknowledgement is made to the Conservation Districts, Regional Planning Agencies, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey (Water Resources Division), and the Massachusetts Executive Office of Environmental Affairs for their assistance in the development of this report. Thanks is extended to the many persons who gave of their time to review the drafts and who gave valuable suggestions.

Special acknowledgement is made to the personnel of the Massachusetts Division of Water Resources who prepared the material for Appendix C and provided continuing assistance throughout the development of this report. Also, a special thanks to the College of Food and Natural Resources, University of Massachusetts at Amherst, for assistance in agricultural land mapping and use of their data on land use, natural resources, and economics.

COVER--A view of Wachusett Mountain from the shores of Wachusett Lake. A water supply for the City of Fitchburg located in Westminster and Princeton, Massachusetts.

Courtesy of: Mass. Dept. of Environmental Mgt.

MASSACHUSETTS WATER RESOURCES STUDY

CENTRAL REGION REPORT

TABLE OF CONTENTS

Page

Page

LIST OF APPENDICES

TABLES

TABLES - cont.

TABLES - cont.

FIGURES

CHAPTER 1

SUMMARY

1.1 INTRODUCTION

This is a report, of a study, on the water and related land resources of the Central Region, prepared by the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission. There are similar reports for the other regions of Massachusetts. The objectives of this study are to identify resource problems, determine needs through 1990, and suggest alternatives which can be used by the Massachusetts Water Resources Commission to prepare a comprehensive state water and related land resources plan. Information contained in this report should be useful to state, regional, and local agencies concerned with land use and natural resource planning.

For the purposes of the Massachusetts Water Resources Study, the state was divided into four regions: Berkshire, Connecticut River, Central, and Coastal. The Charles River Basin was not included, since studies[1/] in that area were completed in 1972 in a cooperative Charles River Implementation Study,[2/] with the Corps of Engineers. Figure 1.1 shows the location of the regions within the state.

The Central Region covers approximately 1,700 square miles and includes parts of three major watersheds: the Merrimack, the Blackstone, and the Thames. The major streams are the: Merrimack, Shawsheen, Assabet, Concord, Sudbury, Squanacook, Nashua, Stillwater, Quinapoxet, Blackstone, Mill, Quinsigamond, Mumford, Kettle Brook, Quinebaug, and French. There are 79 cities and towns in the region. A listing of cities and towns by study area is in Chapter 5, Table 5.20 (Wetland Areas).

The Soil Conservation Service, Economics, Statistics and Cooperatives Service and Forest Service, are the United States Department of Agriculture agencies participating in this study. The Massachusetts Divisions of Water Resources, Fisheries and Wildlife, Forests and Parks, and the Water Pollution Control are the state agencies most actively involved in this study.

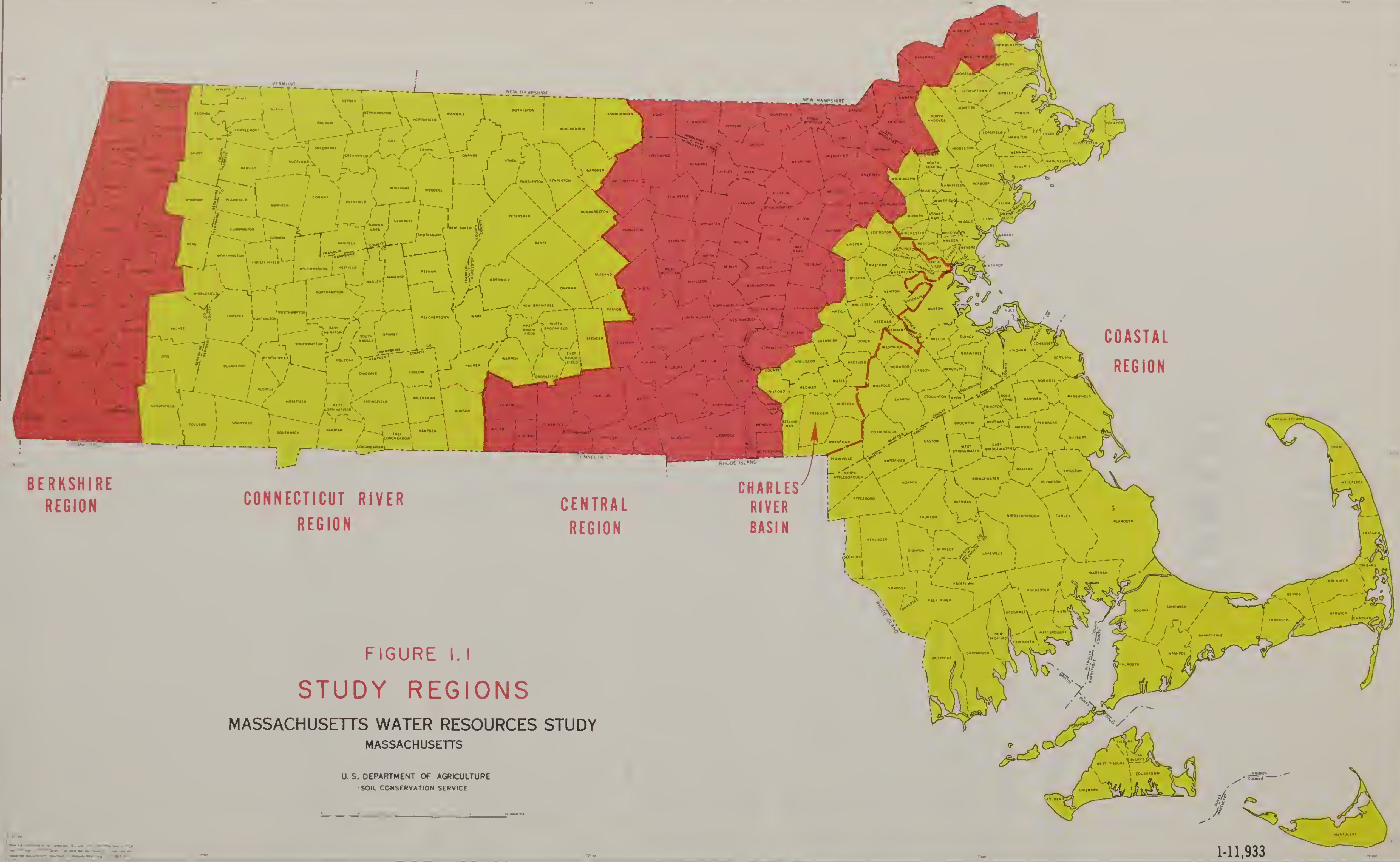

FIGURE 1.1

STUDY REGIONS

MASSACHUSETTS WATER RESOURCES STUDY

MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

1.2 FINDINGS OF THIS STUDY

1.2A Land Use

In 1975 there were approximately 1,255,000 people in the region. The population is expected to increase around 18 percent to about 1,485,200 people by 1990.

Forest is the dominant land use in the Central Region covering approximately 61 percent of the land area or 664,505 acres. Over 17 percent of the land is in urban uses with only 9.4 percent in agricultural use. Wetlands, water, and "other" land uses make up the balance.

During the 20-year period between 1952 and 1972, significant changes in land use have occurred. Agricultural land decreased by 50 percent (100,000 acres) while urban land increased over 139 percent (108,474 acres). Projections based on trends prior to 1974 suggest that total land in farms will decrease between 22,623 and 68,917 acres between 1974 and 1990. Projections also indicate that urban land is expected to increase by 48 percent (89,773 acres) by 1990.

The state as well as the region is experiencing a continuing decrease in the quantity of agricultural land. The loss of suitable farmland soils to other land uses is nearly irreversible. In addition to reducing the land base available for growing food, the loss of farmland results in a deterioration of the visual and aesthetic quality of the environment. Alternatives and remedial measures such as, zoning, purchase of development rights, and acquisition, are suggested which, if implemented, would decrease the loss of agricultural land.

The forest resource provides wood products, water, forage, wildlife, and recreation. Private owners own the majority of the forested land, and much of the land consists of small tracts. A small proportion of forest land is owned for timber production and perhaps only one-half of this land is available for wood product production. Alternatives to increase wood product production include an increase in technical assistance; increase in forest program funding and forest production incentives; develop diversified markets for low quality wood; increase in information and education programs.

1.2B Inland Flooding

Within the last 50 years many floods have occurred in the region. Major regional floods occurred in 1936, 1938, 1955, and 1968. These floods damaged residences, commercial buildings, industrial plants, farm fields, roads, and bridges. Average annual flood damage in the region exceeds $4,900,000 and a 100-year frequency flood would cause damage in excess of $80 million.

Flood plain management programs such as flood plain zoning are being adopted

by many towns in the region. These programs will minimize flood damage in future developments but will not reduce flood damages to existing developments in flood plains. However, flood insurance can reduce the monetary risk for individuals. Seventy-six towns have joined the National Flood Insurance Program and property owners can now purchase low cost flood insurance. In return for federally-subsidized insurance, towns are required to regulate future construction in flood hazard areas. As a result of the flood insurance program and the growing tendency to adopt flood plain management measures, future flood plain development is expected to be highly restricted. As a consequence, flood damage is not expected to increase significantly.

Because of the many existing developments in flood plains, alternatives to reduce flood damage to an acceptable level in the region are needed. Alternatives are available to significantly reduce flood damage. Three corrective flood plain management techniques were investigated in this study. Floodproofing, structural measures, and a combination of floodproofing and structural measures offer viable alternatives to continued flood damage.

1.2C Erosion and Sediment

The region is blessed with generally less severe erosion and sedimentation problems than much of the rest of the United States. However, these problems cannot be discounted entirely. The annual erosion in the region is nearly 644,000 tons. About 64,000 tons of sediment are delivered to watercourses each year. Erosion from construction sites is the largest source and accounts for over 250,000 tons per year.

Enactment of erosion and sediment control ordinances, earth removal ordinances, stabilization of critical erosion problem areas, and increased emphasis on management and the installation of land treatment measures on tilled cropland are suggested as alternatives to alleviate the erosion and sediment problems.

1.2D Wetlands

The 82,000 acres of inland wetlands and 2,500 acres of saltwater wetlands in in the region provide many benefits which include, flood control, wildlife habitat, open space, and water quality protection. The ongoing wetlands programs, especially Massachusetts' pioneer wetlands legislation, will go far in protecting wetlands from harmful alteration. Diligent application of the Wetlands Protection Act (Mass. G.L., Ch. 131, Sec. 40) is the foundation on which the wetland alternatives are based.

Increased public acquisition of wetlands, acceleration of the Inland Wetlands Restriction Program (Ch. 131, Sec. 40A), diligent application of the Wetlands Protection Act (Ch. 131, Sec. 40), and expanded conservancy zoning of wetlands are included in the alternatives.

1.2E Water Supply and Irrigation

Municipal water for the Central Region comes from both ground water and surface sources. It may be supplied by private concerns, municipalities or the Metropolitan District Commission (MDC). Appendix A of this report identifies potential reservoir sites which might fill needs for municipal water supply for individual communities or small regional systems.

Irrigation water used by agriculture represents a very small part of the total water supply and water use in the region. Water supplies for this purpose are expected to be adequate to meet 1990 needs.

1.2F Water Quality

Existing programs and regulations are adequate to enable the region to meet water quality goals. Point sources of pollution have been drastically reduced in the past 5 years and additional progress is expected. Nonpoint sources of water pollution are receiving increased attention under Section 208 of the Water Pollution Control Act Amendments of 1972.

The Nashua River and the Blackstone River were two of the most grossly polluted rivers in Massachusetts. However, with the new and planned sewage treatment facilities in the Nashua River Basin, improvement of water quality has been noted and is expected to continue as the treatment plant construction program nears completion. Similarly with the Blackstone and the other major rivers of the region, water quality improvement is first dependent on adequate treatment of point sources.

1.2G Recreation

Projections in the Statewide Comprehensive Outdoor Recreation Plan indicate that an unmet demand exists now and will exist in 1990 for camping, picnicking, and hiking. Alternatives are presented which will meet some of the needs. These include development of greenways, and implementation of the Massachusetts Scenic and Recreational Rivers Act.

1.3 SUMMARY

Table 1.1 summarizes the major findings, problems, potential solutions and program opportunities determined as a result of this study.

TABLE 1.1 PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
1. Land Use	1. Agricultural land acreage has declined 50% from 1952 to 1972 & is projected to decline further.	Develop programs that help maintain agricultural land use.	Identify important farm land.	Farm management and farm account work at U. of Mass. Cooperative Extension Service.
		Complete soil surveys.	Soil survey program.	Chapter 61A of the Mass. General Laws, Chapter 780, Acts of 1977, Chapter 232, Acts of 1977.
	2. Forest land (approximately 61% of the region) is underutilized for production of wood products.	Increase management of public & private land.	Resource conservation and development program.	Chapter 61 and 61A of Mass. General Laws Classification and Taxation of Forest Lands and Forest Products.
		Increase incentives to landowners.		
		Develop diversified markets.	Cooperative forest management program.	Small Business Administration.
		Establish an information and education program.	General forestry assistance program.	
			Harvest improvement program.	
			Forestry incentives program.	
			Sawmill improvement program.	

TABLE 1.1 - cont. PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities: USDA	Program Opportunities: Other
2. Flooding	1. Future urban flood plain development is expected to be highly restricted.	Enroll towns not now in National Flood Insurance Program.	PL 83-566, Watershed protection & Flood Prevention Act, SCS.	HUD National Flood Insurance Program. Ch. 131, Sec. 40 Wetlands Protection Act. Ch. 131, Sec. 40A Inland Wetland Restriction Act.
	2. Average annual flood damage to existing development exceeds $4,900,000.	Implement plans for structural and nonstructural measures.	RC&D Program, SCS.	Corps pf Engineers' Small Watersheds and Emergency Projects.
3. Erosion and Sediment	1. Erosion on construction sites is excessive.	Develop erosion and sediment control ordinances at the municipal level.	Conservation Operations Program, SCS.	Technical assistance from Conservation Districts with inputs from Cooperative Extension Service and County Regional Planning Commissions.
	2. Region has some critical erosion problem areas and eroding streambanks.	Develop measures to stabilize critical areas and problem streambanks.	Agricultural Conservation Program, ASCS. RC&D Program, SCS.	Gen. Law Ch. 40, Sec. 21, Zoning Act.
	3. Erosion rates on approximately 20% of tilled cropland are unacceptably high and result in lowered agricultural productivity.	Inventory cropland with serious erosion problems. Establish priorities for technical and financial assistance to assist landowners install practices to reduce erosion losses.	Conservation Operations Program, SCS. Soil & Water Conservation Loans, FmHA Agricultural Conservation Program, ASCS.	Technical assistance from Conservation Districts.
	4. Sediments from all types of erosion contribute to the deterioration of water quality.			

TABLE 1.1 - cont. PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities USDA	Program Opportunities Other
4. Wetlands	1. Region has 82,000 acres of inland wetlands which should be protected from harmful alteration.	Accelerate Restrictions and zoning.		Inland Wetlands Restriction Act, Mass. Ch. 131, Sec. 140A. Wetlands Protection Act, Mass. Ch. 131, Sec. 140.
		Acquire 15,700 acres of inland wetlands by 1990.		Financial assistance for cities and towns for acquisition, state - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11.
				Federal - USDI - BOR Land and Water Conservation Fund.
		Expand conservancy zoning to include majority of the region's wetlands.	Mass. Natural Resources Technical Team.	Technical assistance from Conservation Districts.
5. Water Supply and Irrigation	1. Additional municipal water supply will be needed by 1990.	Additional water supply can be developed from groundwater and/or surface water sources.	USDA Farmers Home Administration loans for community water supply systems.	HUD loans and financial assistance for municipal water supply.
		Potential surface water reservoirs indicated in Appendix A.	Resource Conservation and Development Program	
	2. Little irrigation water use, except for truck crops and dwarf orchards. Existing programs are adequate.			

TABLE 1.1 - cont. PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
6. Water Quality	1. "Section 208" water quality studies are underway to control point and nonpoint pollution.			
	2. Sediment from land and streambank erosion.	Same potential solutions, needed actions, and program opportunities as listed under Erosion and Sediment (Resource Area 3).		
7. Recreation	1. There are insufficient camping, picnicking, and hiking facilities.	Provide additional camping, picnicking, and hiking facilities.	Small Watershed Program (PL-566). Resource Conservation and Development Program.	USDI - BOR Land and Water Conservation Fund. Mass. - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11. Mass. - Public Access Fund, Gen. Laws, Ch. 21, Sec. 17.
	2. Region has numerous unique natural features.	Plan for preservation of scenic rivers and unique natural areas.	Renewable Resources Program (F.S.). Natural Resource Planning Program (SCS).	Nature Conservancy Programs, Trustees of Reservations and Mass. Audubon Society. Mass. Div. of Forests and Parks. Mass. Scenic and Recreational Rivers Program.

NOTES

1/ Charles Study Area, U.S. Department of Agriculture, Amherst, Massachusetts, May 1972.

2/ Water Resources Development Plan, Charles River Watershed, Massachusetts, U.S. Army Corps of Engineers, Waltham, Massachusetts, April 1972.

SCS PHOTO

Princeton, Mass.

CHAPTER 2

INTRODUCTION

2.1 GENERAL

The Massachusetts Water Resources Study was initiated by a cooperative agreement between the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission (MWRC). This water and related land resources study provides data for the Commission's use in the preparation of an overall State Water and Related Land Resources Plan.

2.2 AUTHORITY FOR USDA AND OTHERS' PARTICIPATION

The USDA participated in this study at the request of the MWRC. Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended) authorizes such participation by USDA. The Soil Conservation Service, Economics, Statistics, and Cooperatives Service, and The Forest Service, are the USDA agencies participating in this study.

Under state law the MWRC has the responsibility to develop an overall plan, and to coordinate federal, state, and other agencies in the water resources field.

The Massachusetts Divisions of Water Resources, Forests and Parks, Fisheries and Wildlife, and Water Pollution Control are the state agencies most actively involved in this study.

2.3 OBJECTIVES AND NATURE OF STUDY

Water and related land resource planning by federal agencies is guided by the Principles and Standards (P&S) established by the U.S. Water Resources Council.[1/] This guide establishes a thorough and organized approach to water and related land resource planning for two broad national objectives:

1. National Economic Development (NED)--to enhance national economic development by increasing the value of the nation's output of goods and services and improving national economic efficiency.

2. Environmental Quality (EQ)--to enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

Specific objectives are listed in Chapter 3, Problems and Objectives.

2.4 PLANNING PROCEDURES AND REPORT PRESENTATION

The P&S planning process is designed to produce a recommended plan, while the Massachusetts Water Resources Study planning process stops with the development and evaluation of alternatives. The selection of a final or recommended plan is the responsiblity of the Massachusetts Water Resources Commission.

This study investigated the following resource areas in detail: Land Use, Inland Flooding, Erosion and Sediment, and Wetlands. The resource areas of Water Quality, Water Supply and Irrigation, Drainage, Fish and Wildlife, and Recreation are ordinarily subjects of investigation for a cooperative water resources study. In the Central Region, however, these resource areas have or are being studied in detail by others. To avoid duplication of effort and to permit more time and effort to be expended upon the four areas studied in detail, it was decided to briefly investigate the other areas. In some cases, the data and conclusions from previous studies are reported to maintain continuity. In other instances, it was found that new resource data could be generated in a specific phase of a resource area. The principles which guided the study intensity were:

1. areas that were adequately covered by previous studies would not be restudied, and

2. only resource areas where the expertise of USDA agencies is recognized would be studied in detail.

The Massachusetts Water Resources Study planning process approximates the first four steps of the P&S process which are as follows:

1. Specify components of the objectives relevant to the planning setting.

2. Evaluate resource capabilities and expected conditions without any plan.

3. Formulate alternative plans to achieve varying levels of contributions to the specified components of the objectives.

4. Analyze the differences among alternative plans which reflect different emphasis among the specified components of the objectives.

In addition the P&S requires that beneficial and adverse effects of alternatives or plans on National Economic Development and Environmental Quality be displayed. It also suggests that beneficial and adverse effects of alternatives be displayed, where appropriate, for Regional Development and Social Well-Being.

Study results are presented in chapters according to River Basins Memo RB-12 which reflect the P&S suggested planning process. Data findings in each resource area are placed in the appropriate planning chapter, so that the final report enables the reader to follow the step-by-step procedures used to develop the alternatives. The major chapter format is, as follows:

Chapter 1 (Summary) ---- A brief introduction and summary of the findings in this report.

Chapter 2 (Introduction) ---- Outlines the purpose, authority and objectives of the report, along with a general description of the study area. It also acknowledges the assistance and cooperation of others.

Chapter 3 (Problems and Objectives) ---- The resource problems are stated in terms of their effect on the two main objectives: National Economic Development and Environmental Quality.

Chapter 4 (Economic Projections and Environmental Consideration) ---- Projections of social, economic, and natural resources base data are presented, including projections of population, employment, income, urban development, agricultural and forest activity, and other significant social and economic areas. The relationship between the projections and specific components of the National Economic Development objectives are presented. Projections concerning the environmental setting are also contained in this chapter. Effects of population distribution and land use changes on the environment are discussed.

Chapter 5 (Resource Base and Existing Programs) ---- The existing situation is presented in this chapter. Physical data, such as location, size, soils, geology, vegetative cover, climate, and land use are included. Existing conditions in the four major resource areas (flooding, erosion and sediment, wetlands, and land use) are covered in detail. Existing USDA and other programs which are being utilized to meet resource needs are explained in this chapter.

Chapter 6 (Future-Without-Plan Condition) ---- This chapter describes the conditions to be expected in each of the resource areas if no new alternatives are planned and implemented. The effects of presently authorized projects are considered along with the effects of nonaction.

Chapter 7 (Needs) ---- Needs are defined as the difference between conditions expressed in the Economic Projections and Environmental Considerations section and those adequately addressed by ongoing and planned projects described in the Future-Without-Plan Condition Chapter. This chapter quantifies the extent of the problems outlined in the Problems and Objectives Chapter.

Chapter 8 (Alternatives) ---- This chapter presents a number of alternatives designed to fill the needs expressed in the preceding chapter. Displays showing effects of the alternatives on the four P&S accounts (National Economic Development, Environmental Quality, Regional Development, and Social Well-Being) are included. Alternatives and their potential effects on about 20 major environmental indicators will also be examined.

Chapter 9 (Program Implementation of Alternatives) ---- This chapter describes how USDA programs can be used to implement the alternatives expressed in Chapter 8. Opportunities for other state or federal programs are also discussed. If no existing programs are available to implement an alternative, the need for new or revised programs is investigated.

2.5 GENERAL DESCRIPTION OF THE STUDY AREA

For the Massachusetts Water Resources Studies, the state was divided into four regions: Berkshire, Connecticut River, Central, and the Coastal. Reports have been completed for the Berkshire Region, and on the Charles River Basin in the central portion of the Coastal Region.

The Central Region includes all of the Merrimack, Blackstone, and Thames Rivers within Massachusetts. This region is bounded by the Connecticut border to the south, the New Hampshire border to the north, Connecticut River Watershed to the west, and the independent coastal drainages to the east. Only in the northeast where the Merrimack River flows into the Atlantic Ocean does the Central Region have any coastline.

The region includes parts of four counties, Worcester, Middlesex, Essex, and Hampden. Population densities are much lower in this region than found along the coastal areas to the east. Industry and services related enterprises are the principal means of employment.

The region is composed of 79 towns or cities which are divided into five study areas defined on either a watershed or on a natural boundary basis. The five study areas are the Merrimack, SuAsCo, Nashua, Blackstone and Thames, (see Figure 2.1). The SuAsCo and Nashua study areas are upstream tributaries to the Merrimack River. There is one complete Standard Metropolitan Statistical Area (SMSA) (the Worcester-Fitchburg-Leominster complex) and portions of three others (Lowell-Lawrence-Haverhill, Boston, and Providence-Pawtucket-Warwick, Rhode Island) within the region.

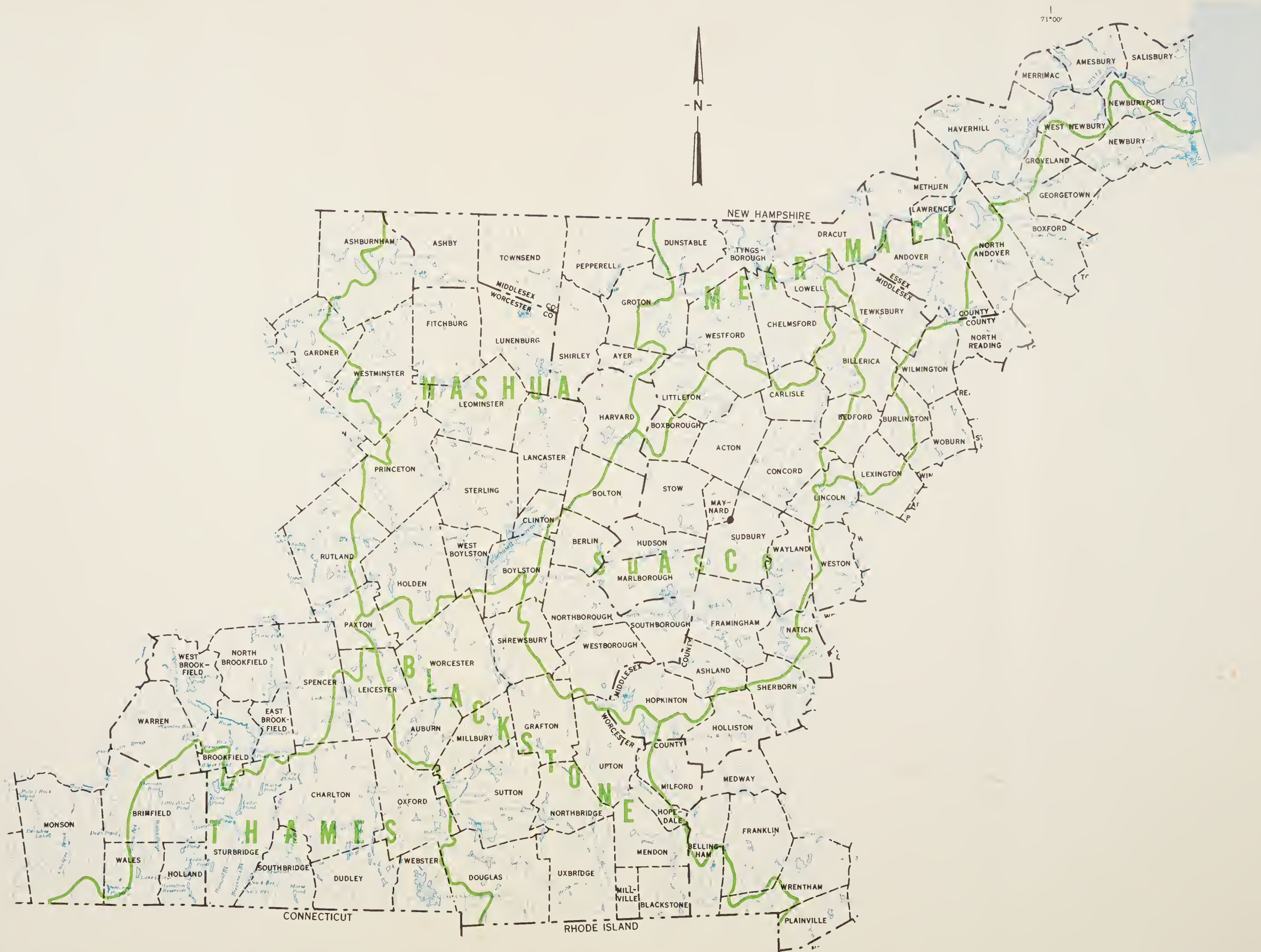

FIGURE 2.1

TOWNS AND STUDY AREAS

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Where applicable, data and findings will be presented for each study area and occasionally by SMSA's. In those cases where no improvement will be made, presentations will be for the entire Central Region.

2.6 POPULATION

The 1975 total permanent population of the Central Region was 1,255,076 an increase of 42,339 (3.5 percent) since 1970 and an increase of 220,945 (21.4 percent) since 1960. It is interesting to note, that of the three-city complex comprising the core of the Worcester-Fitchburg-Leominster SMSA, two lost population between 1970 and 1975. The U.S. census figures show that the populations of Lowell, Haverhill and Lawrence have been declining since 1920. Table 2.1 summarizes the permanent population trends by substudy areas.

TABLE 2.1 POPULATION AND POPULATION CHANGES 1950-1975

	SUBSTUDY					
	Merrimack	Nashua	Blackstone	SuAsCo	Thames	Total Central Reg.
1950	317,947	127,395	266,578	130,662	55,991	898,573
1960	346,734	157,140	261,549	204,613	64,095	1,034,131
1970	405,116	178,334	261,780	294,803	72,704	1,212,737
1975	424,786	174,566	257,397	323,816	74,511	1,255,076
Change 1950-75	106,839	47,171	9,181	193,154	18,520	356,503
% Change 1950-75	33.6	37.03	3.44	147.83	33.08	39.67
Change 1960-75	78,052	17,426	-4,152	119,203	10,416	220,945
% Change 1960-75	22.51	11.10	-1.59	58.26	16.25	21.36
Change 1970-75	19,670	-3,768	-4,383	29,013	1,807	42,339
% Change 1970-75	4.86	-2.11	-1.67	9.84	2.48	3.49

Source: U.S. Census, City and Town Monographs - Massachusetts Department of Commerce and Development, and Regional Planning Commissions.

2.7 ECONOMIC ACTIVITY

Most of the towns and cities in the Central Region were established during the late 1600s and early 1700s with a few towns being established in the early 1800s. Initially, the economic activity in the region centered around a subsistence form of agriculture which was nearly self-sufficient. As population and settlement grew, demands for surplus production arose. As agricultural production increased and as newer technologies were adopted to meet the increased demand, labor that was formerly employed in agriculture was freed to work in nonagricultural activities and thus became more specialized.

Typical enterprises included sawmills and grist mills; brick-making factories; cotton and wool mills; paper; tanneries; and boot and shoe factories. Most of the early towns or cities were established on the various rivers in the region primarily because such rivers supplied inexpensive water power. With the advent of steam power in the late 1800s, canals and water transportation were replaced by railroads. Towns were effected either positively or adversely, depending upon the railroad routes.

Presently, manufacturing is the largest employer of any of the various economic and industrial classifications. In 1971 manufacturing employed 49.4 percent of the labor force in the region. Wholesale and retail trade employed 24.2 percent and the service sector employed 12.2 percent. Table 2.2 summarizes the various employments and percentages by substudy areas.

SCS PHOTO

TABLE 2.2

EMPLOYMENT BY SUBSTUDY AREA, 1971

	Merrimack	Nashua	Blackstone	SuAsCo	Thames	Total	Percent of Region 1/	Percent of State 2/	Percent of National 3/
Agriculture & Mining	350	128	152	471	43	1,144	.3	.7	4.8
Construction	5,182	2,214	3,906	4,453	748	16,503	4.9	4.3	6.3
Manufacturing	49,521	22,425	43,902	40,368	11,193	167,409	49.4	33.8	27.1
Transportation, Communi-cations & Utilities	2,906	1,173	5,711	4,658	465	14,913	4.4	6.0	7.0
Wholesale & Retail Trade	27,048	9,633	22,581	19,403	3,251	81,916	24.2	26.2	21.3
Finance, Insurance & Real Estate	4,321	1,141	6,305	2,398	214	14,379	4.2	7.0	5.2
Service Industrial	15,893	4,469	9,694	9,523	1,589	41,168	12.2	22.0	28.0
Total 1/	106,262	41,303	92,250	81,310	17,537	338,662	99.6	100.	99.7
1970 Population	405,116	178,334	261,780	294,803	72,704	1,212,737			
Ratio Employment Total Polulation Percent	26.2	23.2	35.2	27.6	24.1	27.91		31.9	36.0

1/ Individual entries may not sum to 100 percent due to rounding.
2/ Computed from county business patterns, 1971-72 Massachusetts. USDC Bureau of Sciences.
3/ Computed from 1972 OBERS Projection, Series E Population, Vol. 4 USWRC.

Source: City and Town Monographs, Massachusetts Department of Commerce and Development, Revised 1973.

NOTES

1/ Water Resources Council, Water and Related Resources Establishment of Principles and Standards for Planning, Federal Register, Vol. 38, No. 174, Part III, September 10, 1973.

DIV OF FISHERIES & WILDLIFE PHOTO

Minute Man, Concord, Mass.

CHAPTER 3

PROBLEMS and OBJECTIVES

3.1 INTRODUCTION - PRINCIPLES AND STANDARDS

According to the U.S. Water Resources Council's Principles and Standards for Planning Water and Related Land Resources, the overall purpose of water and land resource planning is to promote the quality of life by reflecting society's preferences for attainment of two major objectives:

1. The enhancement of National Economic Development (NED) by increasing the value of the nation's output of goods and services, and improving national economic efficiency.

2. The enhancement of the Environmental Quality (EQ) by the management, conservation, preservation, location, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The NED objective is attained by measures and actions which result in an increase in the value of goods and services and which improve national economic efficiency. An important component of the NED objective is the value of increased output of goods and services resulting from an action. Water resource alternatives can result in increased production of goods and services which can be measured in terms of increased crop yields, increased recreational use, and reduced flood damages. Increased production from the employment of otherwise unemployed or underemployed resources may also result.

The EQ objective reflects concern for the natural environment and its maintenance and enhancement as a source of enjoyment and a heritage for future generations. Emphasis is given to diverting a portion of the available resources from economic development to achieve environmental goals. As standards of living increase, there is less willingness to accept environmental damage in exchange for economic gain. Specific components of the EQ objective include:

1. Creation or improvement of areas of natural beauty and human enjoyment such as open space, wild and scenic rivers, lakes, beaches, and wild areas.

2. Management or enhancement of valuable archeological, historical, biological, and geological resources.

3. Enhancement of the quality of water, land, and air resources by control and prevention of pollution, erosion, and misuse.

4. Caution in meeting development objectives in order to minimize undesirable and possible irreversible changes in the natural environment.

In each of the major water resource areas of concern, problems can be related to one or both of the major national objectives. Flood damages are a good example of a problem which fits into the category of a National Economic Development problem; i.e., flood damage results in a decrease in the value of goods and services which are produced in an area. The problem of regional wetlands loss might logically be classed as both a NED and EQ problem. Loss of wetlands results in loss of wildlife habitat (an EQ loss), as well as decreasing floodwater storage and consequently increasing flood damage downstream (an NED problem).

3.2 PROBLEMS AND OBJECTIVES

Table 3.1 presents problems or concerns for each specific resource area or study concern. Objectives related to problems are presented on two major levels: desires and preferences.

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TABLE 3.1

PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives: 1st Level (Desires)	Objectives: 2nd Level (Preferences)
Land Use - Agricultural Land	EQ - Loss of open land.	Preserve open land.	Maintain a viable agricultural sector in order to preserve agricultural land and, thereby, preserve an aesthetically pleasing land use mix.
	NED - Loss of agricultural land to nonagricultural uses, thus decreasing agricultural production.	Preserve agricultural land to maintain or increase agricultural output.	Increase net returns to agricultural sector. Determine and minimize the factors that adversely impact upon the agricultural sector.
Land Use - Forest land	EQ - Lack of forest management in urban areas is resulting in a lessening of environmental quality.	Preserve, maintain, and enhance the quality of the environment and the ecological system.	Provide information and education programs on urban forestry. Provide additional technical assistance for management and use of urban forest resources in the region.
	NED - Underutilization of forest land resources for the production of wood products.	Increased outputs of wood products.	Increase management opportunities for forest landowners. Provide forest land management incentives. Increase market opportunities for wood products. Establish and increase information and education programs on forest management.
Inland Flooding	NED - Periodic flooding causes damage to existing residential, commercial, industrial, and public property.	Reduction of flood damage to existing damageable property.	Reduction of flood flows. Reduction of susceptibility to flooding.
	NED - Development of flood prone areas increases the damages to be expected from future floods.	Improved economic efficiency from development of flood-free areas.	Guide development away from flood prone areas.
	NED - Loss of wetland flood storage increases flood peaks and flood damage.	Avoid increased flood peaks and resulting damage.	Protection of wetland flood storage from loss by filling.

TABLE 3.1 - cont.

PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives: 1st Level (Desires)	Objectives: 2nd Level (Preferences)
Erosion and Sediment	EQ - Materials eroded from unstable areas are resulting in pollution and sedimentation of water bodies and decreased visual quality.	Enhance water quality.	Install erosion and sediment control measures.
		Enhance visual quality.	Install erosion and sediment control measures.
	NED - Erosion on cropland results in reduced agricultural productivity.	Maintain agricultural productivity.	Reduce erosion losses on those croplands with (about 20%) unacceptable erosion rates.
Wetlands	EQ - Loss or harmful alteration of inland wetlands results in decreased wildlife habitat and visual quality.	Protection of the environmental base.	Protection of wetlands from unwise development.
	NED - Loss of wetland flood storage increases downstream flood peaks and flood damage.	Avoid increased flood peaks and resulting damage.	Protection of wetland flood storage from loss by filling.
	NED - Development of wetlands increases flood damage in the developed wetlands.	Reduce future flood damage.	Protect wetland flood prone areas from development.
	NED - Lack of public access to wetlands is resulting in underutilization of a recreation resource.	Increase wetland recreation opportunities.	Secure public access to wetlands.

TABLE 3.1 - cont.

PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Water Supply	NED - Existing municipal water supplies will be insufficient to meet 1990 needs.	Increase available municipal water supply yield.	Develop new municipal water sources. Improve existing municipal sources and delivery systems.
Water Quality	EQ - Pollution from point and nonpoint sources is degrading water quality.	Improve water quality.	Identify pollution sources and develop abatement measures.
Recreation	EQ - Unique natural, historic, and cultural resources will be lost unless protected.	Management and protection of areas of natural beauty and human enjoyment.	Protect and manage unique natural, historic, and cultural resources.
	NED - Lack of public access to outdoor recreation resources.	Increase recreational opportunities.	Secure access to recreation areas.
	NED - Demand for outdoor recreation exceeds available supply.	Increase recreational opportunities.	Develop water-based recreational resources.

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CHAPTER 4

ECONOMIC PROJECTIONS and ENVIRONMENTAL CONSIDERATIONS

4.1 HISTORICAL DEVELOPMENT

In terms of major activities, the Central Region has progressed through two economic periods and is presently in a third. The principal activity during initial settlement through the first part of the 1700s was subsistence agriculture. But with the expansion of population in Boston and other centers of trade, demand for food and primary manufactured goods increased. As new technologies were developed, and more land cleared, agriculture production increased while requiring less labor to the extent that some labor was freed to pursue nonagricultural careers. The major industries of this period, were grist mills, sawmills, textile mills, cotton and wool mills, and brick manufacturing. Less important enterprises dealt with the manufacturing of combs, barrels, boots, and shoes, also, some bog iron mining and quarrying. Around 1900 an economic structural change began to occur as the southern states increased their manufacturing in these activities to the detriment of Massachusetts businesses.

Cities such as Lowell and Lawrence, at one time the major textile mill towns in the country, suffered from textile shifts to southern areas which began during the turn of the century. For all intents and purposes, the shift was completed between 1920 and the depression of the 30s. This decline in the textile sector was brought about by two major outside factors. The first factor involved a primary transportation shift from water to land. Initially the railroads brought about this change, which was sealed with subsequent development of more efficient highway systems. The other factor involved the introduction of nonwater generated power systems, initially steam and subsequently, electricity. With the change in these factors, plus higher wage rates, the Region's comparative

advantage disappeared and this dictated a manufacturing decline. Although manufacturing has declined, it still dominates the economic activity in the Region.

The agricultural sector has evolved through three economic or production stages:1/

1. Prerailroad (ending about 1840) -- agricultural production concentrated primarily upon supplying nearby cities.

2. Transition stage (1840-1910) -- staple products were increasingly coming from western areas (i.e. Indiana, Ohio, New York, etc.).

3. Present pattern (1910-present) -- agriculture primarily involved in providing perishable foods produced near point of consumption.

The three agricultural stages occurred as a result of other changes in the economic structure in the eastern half of the United States. Other regions, endowed with higher quality agricultural production resources, and effecient transportation, developed greater comparative advantages with which the eastern states could not compete. As a result, manufacturing became the predominant economic activity. Exports of manufactured goods were utilized to pay for imports of agricultural goods.

Agricultural, forest, fishing and mining enterprises employ less than half of 1 percent of the total labor force in the region and generate an equivalent amount of personal income.1/ As Table 2.2 showed, although these four sectors are relatively insignificant from a direct employment viewpoint, they do provide inputs to many other sectors. From a resource planning perspective, the fact that over 70 percent of the land area is in agricultural and forestry uses means that the simple economic viewpoint does not suffice. These two sectors become extremely significant in that they are critical components in any resource plan. To the extent that the land use mix is associated with water and related land resource management as well as visual and environmental quality, agriculture and forest land must be prime considerations in resource planning.

The quality of the environment is tied very closely to the extent and type of economic activity being carried on in any particular region. In the Colonial period through most of the 1800s, little concern was given to the waste byproducts (externalities) of production and consumption. Air and water were both considered free goods with no cost for their use. But as manufacturing grew, and as population increased, the ever increasing amounts of waste became too concentrated to be assimilated into the environment. Once this stage was reached, air and water quality decreased. As this quality decreased, the expense of cleaning these resources increased to the extent that they generated public concern and

increased awareness of the need for resources planning. This resulted in state and local legislation, which forced users to recognize the importance of clean environmental resources.

4.2 SOCIO-ECONOMIC DATA

4.2A Population[2/]

In 1950, the population in the Central Region was approximately 898,753. By 1960, the population had grown to 1,034,131, an increase of 135,558 (15.1 percent). Between 1960 and 1970, the population grew by 178,606, an increase of 17.3 percent (from 1,034,131 in 1960 to 1,212,737 in 1970). Between 1970 and 1975, the growth of population began to level out and averaged 3.49 percent (an increase of 42,339). Looking at 10 year increments, between 1950 and 1960 the population grew by 15.1 percent; between 1960 and 1970 it grew by 17.3 percent. The 5-year change between 1970 and 1975 would translate into a 10-year growth rate of 6.98 percent. Assuming that this decreasing rate in population growth continues, potential demands upon the water and related land resources will decrease. Past and current population and population changes between 1950 and 1975 were summarized in Chapter 2, Table 2.1.

4.2B Employment

OBERS[3/] data was adjusted to reflect the area in the Central Region. For that reason, the discussion using OBERS data should be considered only as an indication of relative changes in employment and the associated economic activities. Whenever possible, most of the economic material presented here will reflect the characteristics of the Central Region per se. A comparison with OBERS will be undertaken when appropriate. Table 4.1 summarizes OBERS data on employment activity in the Central Region between 1950 and 1970.

TABLE 4.1 PERCENT OF TOTAL EMPLOYMENT EARNINGS BY STANDARD INDUSTRIAL CLASSIFICATION CODE 1950-1970

	1950	1960	1970
Agriculture, Forestry, Fishing and Mining	2.1	1.1	.9
Manufacturing	57.2	51.1	42.5
Construction	3.9	4.4	6.1
Transportation, Utilities, Commodities	4.2	4.6	5.9
Wholesale, Retail Trade	14.0	14.1	14.1
Finance, Insurance, Real Estate	2.6	3.9	4.2
Service	7.9	12.0	14.5
Government	8.0	8.8	11.6

Source: 1972 OBERS, Series E, Vol. V, p. 40 and 258.

In 1950, the manufacturing sector clearly dominated the economic picture in the Region, contributing over 57 percent of total earnings. Although this share has decreased since then (51.1 percent in 1960 and 42.5 percent in 1970), it still thoroughly dominates. Wholesale and retail trade in 1950 and 1960 were the next most dominant sector; but by 1970 the service industry moved into second place. Agriculture, forestry, fishing and mining are relatively insignificant and contribute less than 1 percent to total earnings.

4.2C Income

The Central Region enjoys a per capita income that has consistently been above the National average. In 1975, the National average was $5,449 and the State of Massachusetts averaged $5,757. The Central Region in the same year averaged $5,843.[4/] Expected increases in leisure time together with increases in disposable income will probably result in increased recreational demands and therefore, will result in an increase in demand upon water and related land resources.

4.2D Urban Centers and Their Influences

Major urban areas in the Central Region are: Worcester, Framingham, Leominster, Fitchburg, Lowell, and Lawrence. Although many of the towns are bedroom communities for the Boston metropolitan area, particularly those towns located in the eastern part of the region, Worcester, Lowell, and Lawrence dominate the region. Boston, however, due to its size and proximity, also has a great deal of influence.

4.2E Transportation

The Central Region has a diversified and relatively efficient transportation network. There are numerous interstate, state and local highways in the region. Interstate 495, located east of Worcester runs north and south connecting Lawrence to Lowell and Worcester, and then runs south-southeast until it meets Interstate 95 in Mansfield. The Massachusetts Turnpike (Interstate Route 90) runs in an east-west direction from Springfield to Worcester and then runs east-northeast to Boston. State Route 2 also runs east and west in the northern portion of the region, and connects North Adams in the west to Boston in the east. North-south transportation will be improved with the completion of Route I-190. A large number of state and local roads interconnect the various towns in the region and compliment the major highway system. The major airport serving the Central Region is Logan International Airport, located in Boston. Worcester Municipal Airport, Fitchburg Municipal Airport and numerous smaller airports provide flights to other areas of the state as well as to municipal airports in neighboring states.

In the eastern portion of the region, railroad passenger service is available and is tied closely with Boston's transit network. Western

portions of the region are not as fortunate. The Worcester-Leominster-Fitchburg area is the third largest in the state relative to economic activity. As such, the area is served by railroads which are utilized to bring in raw manufacturing material and to take out finished manufactured goods. The Central Region is well endowed with a diversified and relatively efficient transportation network.

4.3 AGRICULTURAL RESOURCES AND RELATED ECONOMIC ACTIVITY

Agricultural Census Data for the three counties in the Region (Essex, Middlesex, and Worcester) were disaggregated to reflect the portion of each county located in the Region. It was not possible to allocate the census data to reflect the actual boundaries of the substudy areas. As a consequence, the county designations in Table 4.2 approximate a combination of various substudy areas. For example the Worcester designation includes all of the Thames substudy area and the Blackstone, and nearly all of the Nashua. The Middlesex designation incorporates a small proportion of the Nashua substudy area, approximately half of the Merrimack substudy area, and nearly all of the SuAsCo. The Essex designation includes all those towns in the Merrimack study area located in Essex County.

4.3A Major Crop and Livestock Enterprises

The Central Region, like the state, has a well balanced agricultural sector. In this region, the value of all agricultural production amounted to $55,984,000 in 1974. Crops contributed 16.5 percent to this total, livestock 49.4 percent, nurseries and greenhouse operations 33.8 percent and forest products contributed .3 percent of the total.

Table 4.2 offers two sets of numbers detailing the cash receipts, and expenditures of all farms and those farms with sales of $2,500 or more. It is interesting to note that nearly 99 percent of all agricultural production results from those farms having sales of $2,500 or more, yet these same farms represent only 71 percent of the total number of farms. These farms produce crops and livestock worth a total of $55,180,000 which averages out to be $73,770 per farm. On the expense side these same farms had a total cost of production amounting to $48,279,000 which averages to $64,544. Net income per farm is slightly more than $9,000 per farm. In discussing those farms with sales under $2,500, the picture is not nearly so bright. There were 300 farms in this category in 1974 which had a total value of production equal to $804,000 and expenditures to $892,000 which translates into an average loss per farm of $293. When it is considered that these 300 submarginal farms encompass an area of 25,721 acres, which is nearly one-fourth of the projected 1990 agricultural base, their exit from agriculture may have serious consequences for the region, if nonagricultural uses replace the agricultural use.

Closely involved with the above figures is the recent enactment of two development rights bills in the Massachusetts General Court.[5/] The first bill enables city and town governments to purchase the development rights to farmland, thus precluding development on such land. The second bill provides $5,000,000 for this purpose. Depending upon the characteristics of the land resource represented by the submarginal farms, it may be that priority in purchasing their respective development rights might have to be applied. Table 4.2 summarizes agricultural data for three categories of farms: all farms, those with sales greater than $2,500, and those farms with less than $2,500.

4.3B Employment and Income

As mentioned in section 4.1, in comparison with the total Massachusetts economy, the state's agricultural sector is relatively small, with gross cash receipts of approximately $202 million in 1974. The agricultural receipts in the Central Region contributed approximately 28 percent to the state total or $55,984,000. Taking the total cash receipts for all farms and subtracting production expenses of $49,171,000 results in net income of $6,813,000. Dividing this figure by the total number of farms in the region results in an average farm net income of $6,501. When only those farms with sales over $2,500 are examined, the result is an average net income of $9,225, nearly 42 percent higher than the all farm average (see Table 4.2).

When discussing employment in the agricultural sector, it should be noted that certain problems exist when such data is compiled. Most employment data in the state is generated through the Massachusetts State Division of Employment Security. A major problem arises because these organizations collect data for employment covered under the statutes which charter them.

These charters are primarily employment compensation, job referrals, and manpower planning agencies. Although their work has expanded in recent years, their historical data series includes only employment covered by employment compensation acts which amounts to approximately 80 percent of total employment.

4.3C Economic Factors Affecting Agriculture

One of the most obvious signs of poor economic performance of agricultural enterprises is that between 1969 and 1974, agricultural land declined by nearly 20,000 acres from 145,301 to 125,444 acres, a 13.7 percent decline.[6/] The most logical explanation for this decline is that individual farmers simply could not afford to stay in production given the alternative sources of income and/or employment.

There are a number of factors which have contributed to the decline of agriculture in the state and in the Central Region. Probably the most

TABLE 4.2 VALUE AND COSTS OF AGRICULTURAL PRODUCTION, 1974

	Essex	Middlesex	Worcester	Total Region
	- - - - (thousands of dollars) - - - -			
Value of Ag Production				
All farms	4,168	33,058	18,758	55,984
Farms with sales over $2500	4,099	32,684	18,397	55,180
Farms w/sales less than $2500	69	374	361	804
Value of Crop Production				
All farms	816	4,610	3,829	9,255
Farms with sales over $2500	789	4,504	3,734	9,027
Farms w/sales less than $2500	27	106	95	228
Value of Forestry Production				
All farms	13	94	60	167
Farms with sales over $2500	12	86	54	152
Farms w/sales less than $2500	1	8	6	15
Value of nursery, greenhouse products				
All farms	1,490	16,203	1,230	18,923
Farms with sales over $2500	1,480	16,190	1,222	18,892
Farms w/sales less than $2500	10	13	8	31
Value of livestock & livestock products				
All farms	1,848	12,151	13,639	27,638
Farms with sales over $2500	1,817	11,905	13,386	27,108
Farms w/sales less than $2500	31	246	253	530
Production Expenses				
All farms	3,811	29,340	16,020	49,171
Farms with sales over $2500	3,730	28,955	15,594	48,297
Farms w/sales less than $2500	81	385	428	892
Net Receipts				
All farms	357	3,718	2,738	6,813
Farms with sales over $2500	369	3,729	2,803	6,913
Farms w/sales less than $2500	-12	-11	-65	-88
Number of farms	- - - - - - - - - - Number - - - - - - -			
All farms	131	443	474	1,048
Farms with sales over $2500	92	321	335	748
Farms w/sales less than $2500	39	122	139	300
Average size of farms	- - - - - - - - - - Acres - - - - - - - -			
All farms	93	85	160	120
Farms with sales over $2500	110	92	181	134
Farms w/sales less than $2500	52	68	110	85

Source: 1974 Census of Agriculture

significant factor is farm profitability. As was noted earlier, in 1974, 99 percent of the agricultural receipts were accrued by only 71 percent of the farms (the category of farms with over $2,500 in annual sales) in the Central Region. Thus, there were 300 farms with sales of under $2,500 a year. When sales income and expenses are combined, those 300 farms had an average 1974 loss of nearly $295.00. From this vantage point alone, it would seem reasonable that these farms on nearly 25,721 acres may be going out of production, unless supplemented with off-farm generated income.[7/]

Many factors impact upon profitability in the agricultural sector: rising labor and capital equipment cost; shortages of labor; alternative employment with greater pay and shorter hours; taxation; lack of a market output infrastructure (e.g., slaughtering houses, processing plants); nuisance laws; higher transportation rates than in competing regions; climate and land. The Governor and the Commissioner of Agriculture in the State of Massachusetts, in viewing the historical decline of the state's agricultural sector, issued a report entitled A Policy for Food in Agriculture in Massachusetts, wherein a policy to preserve agricultural land was set forth. The trend, from an agricultural perspective, is rather alarming: a decrease from 35,000 farms to a little more than 6,000 since World War II. During the same period, farmland decreased from over two million acres to a little more than 700,000.

As of 1976, Massachusetts was importing 85 percent of all its food. This included 97 percent of its meat, 70 percent of its eggs, 80 percent of its milk, and 90 percent of its potatoes.[8/]

It should be noted, however, that at least 25 percent of the state's total food requirements must be supplied from sources outside the state.[9/] Of this 25 percent of the total food, 15 percent are comprised of such foods as citrus fruits, tropical fruits, sweet potatoes, rice, etc. The remaining 10 percent of the food comes in the form of fresh fruits and vegetables imported from other regions during those seasons when production is not possible in Massachusetts.

There is no question that a ready market for food exists, but it appears that economic conditions are such that Massachusetts farmers are unable to adequately supply this market. As a result of the high import demand for food commodities, Massachusetts' residents pay from 6-10 percent more for their food than the national average.[8/]

As a consequence, the food prices in Boston, for example, are the fourth highest of the 38 major American metropolitan areas. These higher costs have been influenced by high transportation rates (with a decline in rail freight service, a greater reliance has been placed on more expensive trucking) and by the lack of storage facilities in the state.

As initial steps in trying to reverse the trend in agricultural demise,

the Massachusetts legislature has recently passed bills whereby the development rights can be purchased on farmland. The rationale behind the program is that the income that a farmer would receive from selling his development rights could then be reinvested in capital improvements, thus making his operation more efficient and less costly. Land is merely one productive input to a farming operation. However, such a program is, of necessity, a first step.

Tied very closely to the decline in agriculture is the manner in which land resources are allocated to development. Most of the local zoning ordinances zone agricultural land as low density development, at best an inefficient use of a scarce resource. What is necessary is an educational effort whereby local zoning authorities would be able to set more flexible ordinances which would relieve the pressures for development on agricultural land.

It should be pointed out that there are only two food crops in the state wherein production exceeds consumption: sweet corn and cranberries. As a result, it may be necessary to introduce future programs whereby incentives can be generated to produce any given crop or a combination of crops (land, climate, capital, and management permitting). Such a program could involve subsidies, for example, a guaranteed outlet at a guaranteed minimum price.

4.4 FOREST RESOURCE AND RELATED ECONOMIC ACTIVITY

4.4A Extent and Nature of the Resource

Forest land occupies 664,505 acres or approximately 61 percent of the 1,092,056 acres in the Central Region.[10/]

A forest is an association of tree species. The tree species associated on a specific land area are a function of soils, sites, climate, and cultural activities. Figure 4.1 shows the general association of trees in the region, and Figure 4.2 shows the percent of land that is forest covered. Table 4.3 shows tree volume estimates by species and size classes in the region.

4.4B Utilization

The forest resource provides goods and services that benefit the region's economy and environment. These goods and services can be grouped to: (1) wood products; (2) water; (3) forage; (4) wildlife and (5) recreation.

Wood Products [11/]-- The annual sawlog harvest is about 19,200,000 board feet, valued at $1,700,000. The majority of the sawlogs harvested are white pine. Other round wood products are composed primarily of fuel wood and some pulpwood. Approximately 2,000 cords are harvested annually, valued at $40,000.

MASS. DEPT. OF ENVIRONMENTAL MGT. PHOTO

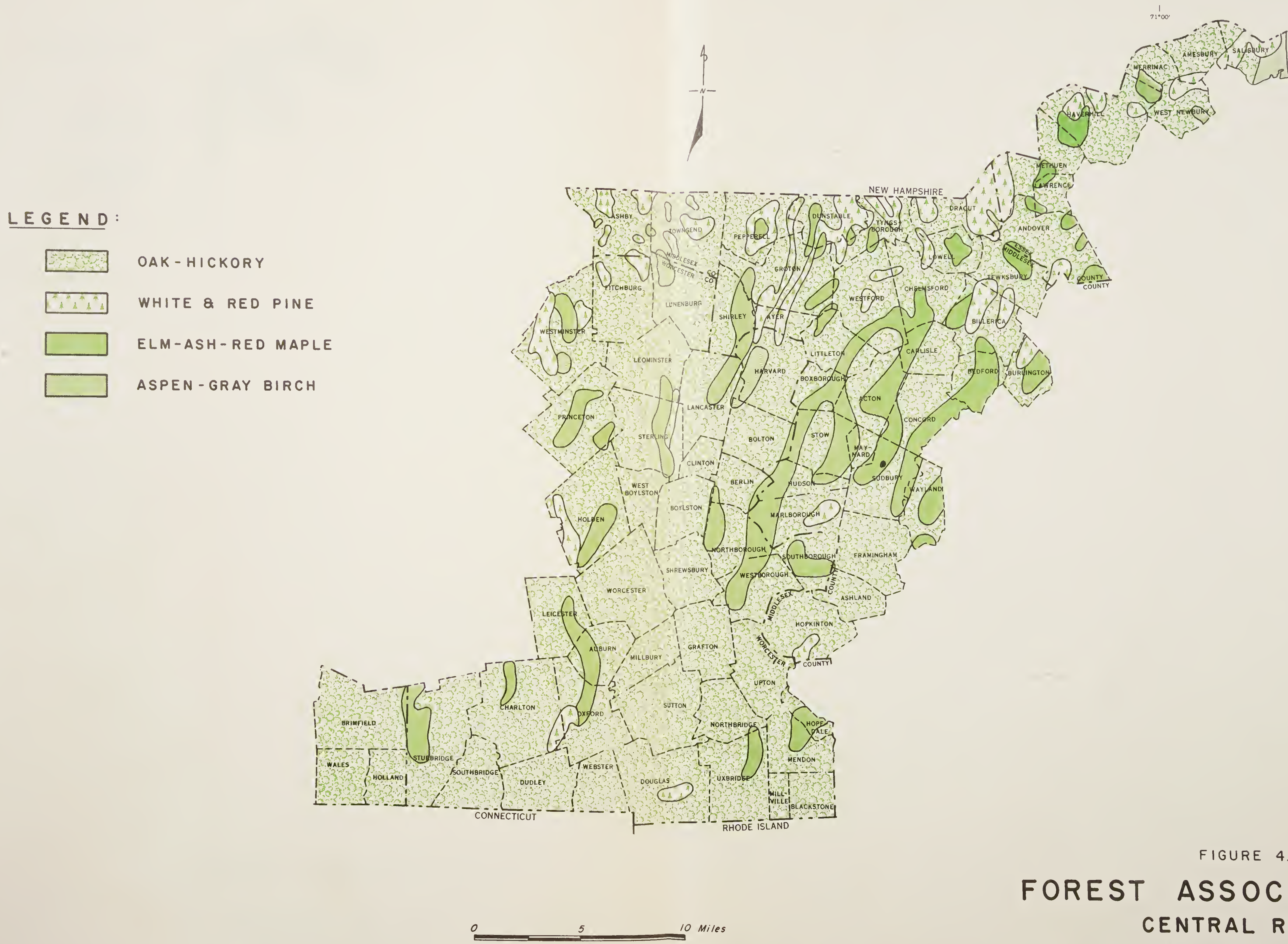

FIGURE 4.1

FOREST ASSOCIATION MAP

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

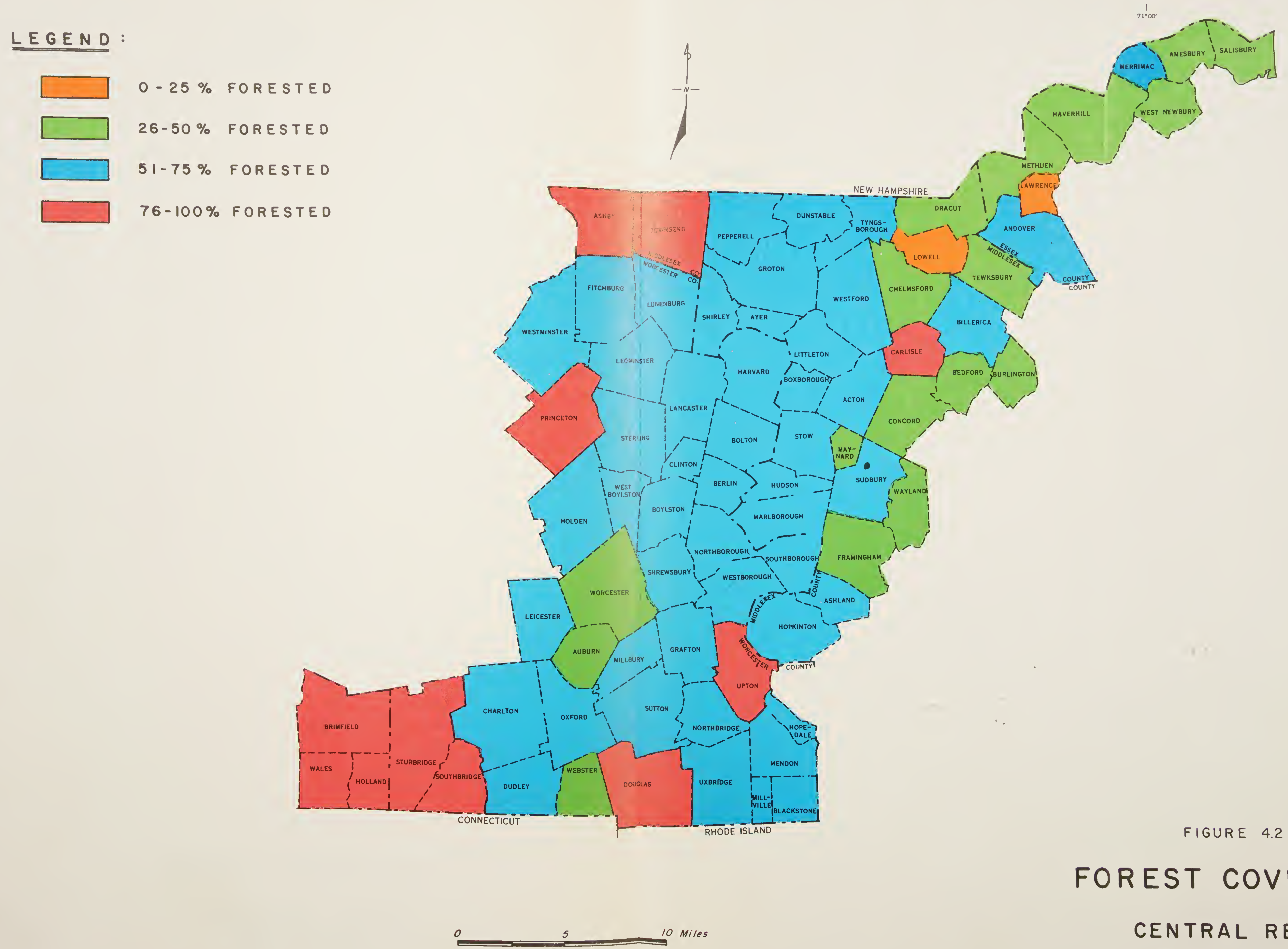

FIGURE 4.2

FOREST COVER MAP

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

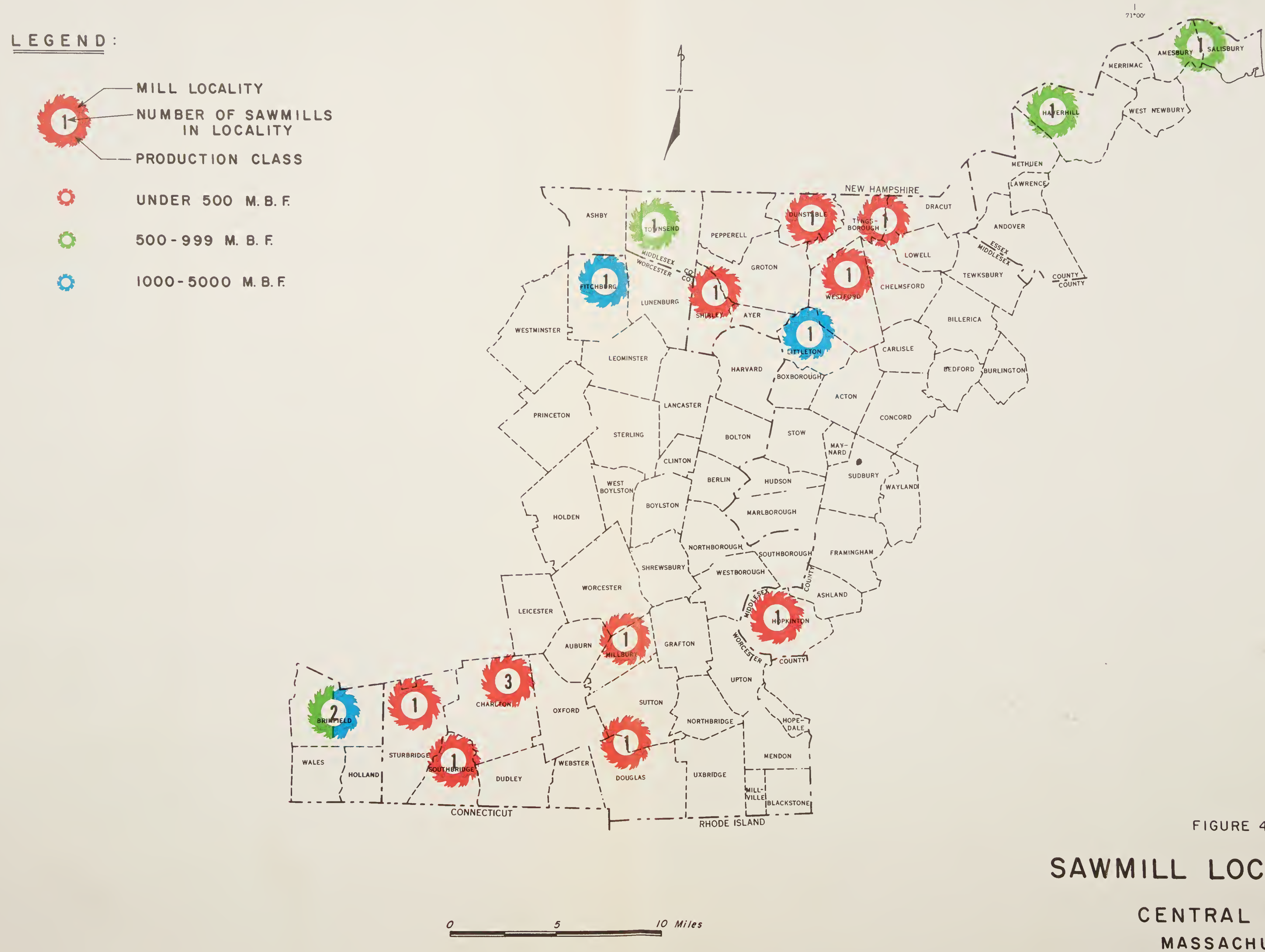

FIGURE 4.3

SAWMILL LOCATION MAP

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 4.3 ESTIMATED NET VOLUME OF GROWING STOCK ON FOREST LAND, BY SPECIES, TREE CLASSES

(In Millions of Cubic Feet)

Species	Total	Species	Total
White Pine	183.1	Paper Birch	12.9
Pitch Pine	13.9	Beech	6.0
Hemlock	21.6	White Ash	9.5
Other Softwoods	17.1	Black Cherry	13.3
Total Softwoods	235.7	Aspen	4.6
		Elm	2.5
Select White Oaks	36.1	Other Hardwoods	4.8
Select Red Oaks	104.5	Total Hardwoods	418.0
Other Oaks	74.4		
Hickory	14.5	All Species	653.7
Sugar Maples	10.4		
Soft Maples	108.6	Sawtimber	304.3
Sweet Birch	10.1	Poletimber	349.4
Yellow Birch	5.8		
		All Classes	653.7

Water[12/] -- Forest land is a source of good quality water. Precipitation falling on forest land is used by the vegetation, evaporated, stored in the soil, or leaves the watershed as streamflow. Streamflow is water yield. Forest land in the region yields 984,000 acre-feet (321 billion gallons) annually, valued at $2,460,000.

Forage[13/] -- There is very little grazing of livestock on forest land. It is unlikely that grazing will ever be an important use of forest land.

Wildlife[14/] -- Forest land is a valuable wildlife habitat. Each 100 acres of well managed eastern hardwood forest can support a fall population of: 3 turkey, 3 deer, 25 grouse, 50 rabbit, 100 squirrel, 180 game animals plus 200 fur animals.

Recreation[15/] -- Recreational activities can be divided into two broad categories, general and specific. General recreation includes activities attractive to the majority of outdoor recreationists and which generally require the development and maintenance of convenient access and adequate facilities. Activities include picnicking, swimming, sightseeing, camping and hiking.

Special recreation includes activities for which opportunities, in general, are limited, intensity of use is low, and often may involve a large personal expense by the user. Activities include hunting, fishing, backpack camping, canoeing and snowmobile touring.

Forest lands in the Central Region provide approximately 1,500,000 visitor days of general recreation annually valued at $3,000,000 and about 1,100,000 visitor days of special recreation annually valued at $5,400,000.

4.4C Cut and Current Growth

The forest resource is underutilized in terms of the potential cut for wood products. A measure of the potential is the growth-cut relationship. Growth is the volume of wood added annually to the inventory of wood and cut is the volume of wood cut annually from the inventory of wood.

Growth averages about 50 cubic feet per acre annually while the cut for wood products averages about 5 cubic feet per acre annually. The growth to product cut ratio of 10:1 indicates that the cut could be increased substantially without touching the inventory base.

The growth-cut ratio does not reveal necessary factors about the resource, such as quality of wood, the economic availability of wood, the volume of wood cut not used for production, and the volume of wood offered for sale by the landowner. These factors together leave only 50 percent of the forest land available for wood products. Chapter 5 discusses land ownership and landowner attitudes in more detail.

4.4D Employment & Income in Primary & Secondary Wood Processing

The primary forest product industry--those companies manufacturing wood products from logs and bolts--is almost exclusively made up of sawmills. No pulp, cooperage, or veneer industries operate in the region. Excluded here are companies or individuals manufacturing fuelwood from logs and bolts. In 1975, 19 commercial sawmills were located in the region.[16/] These are shown on Figure 4.3. Supplying these sawmills with logs and bolts were an estimated eight logging contractors located in the region.

In 1975, approximately 50 people were employed in the sawmill and planing mill industry.[17/] Employee earnings in the sawmill industry are estimated at $350,000.

The secondary forest product industries--those companies using wood which have undergone some previous manufacturing process and use wood exclusively or partially in a further manufacturing process--are quite extensive in the region. These industries include diversified manufacturing processes. Among these are hardwood dimension and flooring mills, millwork, structural wood members, wood boxes and shook, wood household furniture, paper mills and paperboard mills. In 1975, approximately 6,100 people were employed in these wood-based industries.[17/] Employee earnings in these industries are estimated at $6,100,000.

Employment in wood-based industries by Standard Industrial Classification Code (SIC) is shown in the following tabulation (Ibid).

Major Group	Employee
24--Lumber & Wood Products (except furniture)	1,100
25-- Furniture & Fixtures	2,100
26--Paper and Allied Products	2,900
	6,100

4.4E Economic Factors Affecting Forest Resource

Forested land in the region is subject to pressure of urban and industrial developments. The value of forest land solely for the production of wood products cannot compete with the value of converting forest land to these type developments. An estimated 338 acres of forest land are converted annually to other land uses.

Forested land occupies 61 percent of the land area. The extensive forest area speaks well for the potential to make more complete use of the forest resource and the benefits that the forest resource can provide. A number of factors tend to mitigate utilizing the forest land to its potential. The high population density; the high level of development to support the population; the thousands of owners, most of whom own small acreages; the scattered ownership pattern; the diversity of owners' attitudes toward forest property; and the lack of diversified markets for wood products, singly and in combination inhibit an efficient forest management program.

Land to remain in forest cannot effectively compete with land that is to be developed for other more economically advantageous uses. Similarly, the use of forest land for the traditional output of commercial wood products cannot compete effectively with the desires and needs of the people, who for their own solitude, well being, or for whatever nonmonetary reasons own forest land.

4.5 TOURISM AND RELATED ECONOMIC SITUATION

In 1974, tourism in Massachusetts generated over $1,150,000,000 and contributed approximately 3.5 percent of the total income received in the Commonwealth from all sources. Employment utilized in the tourism industry amounted to more than 74,400 year round jobs.

A report entitled The Economic Impact of Tourism on the Commonwealth of Massachusetts[18/] stated the following "There is probably no industry of any consequence to the Commonwealth--and certainly none as important as the tourism industry--about which so little is known." There are a number of possible reasons for this lack of information:

1. It is an industry with a very large number of enterprises--from giant hotels to part-time one person businesses.

2. Customers are not easily identifiable yet amount to some 33 million per year in the Commonwealth.

3. It is an industry whose product is a service, not a commodity.

4. It is an industry whose services are vastly diverse.

The report noted a rather interesting phenomenon concerning the tourism industry. One of the objectives of the study was to determine whether or not other New England states are competitive with Massachusetts, or if the region as a whole attracts the visitors. If it could be shown that the latter is the case then the relationships of the New England states should be considered supportive, not competitive. The report concluded that visitors tend to come to individual states, rather than to the region as a whole. Visitors generally come to Massachusetts or to one or more of the other New England states. Although the report is a preliminary study, a table of total income generated by tourism in Massachusetts was developed. Table 4.4 summarizes the findings.

TABLE 4.4 TOTAL INCOME GENERATED BY TOURISM IN MASSACHUSETTS - 1974

	Accommodations					
	Commercial Lodging	Own Cabin, Trailer	Friends & Relatives	Other[1/]	Day Trip	Total
	(thousands of dollars)					
Purpose of Trip						
Business	199,381	264	38,272	4,261	12,565	254,743
Personal Business	108,456	58,321	38,059	2,581	12,305	219,723
Convention	14,622	0	106	5,330	357	20,415
Visit Friends & Relatives	70,288	2,902	192,110	22,501	15,249	303,050
Recreation, Sightseeing, Entertainment	287,992	48,935	17,785	5,186	9,981	369,879
Total	680,739	110,422	286,332	39,861	50,457	1,167,809

Source: The Economic Impact of Tourism on the Commonwealth, OP cited.

1/ "Other" includes nights on a cruise, boat, or other special facilities for accommodation.

As can be seen tourism does play a rather significant role in the economy of Massachusetts. According to Professor Norman G. Cournoyer, University of Massachusetts, 1975 expenditures by non-Massachusetts travelers amounted to $957,680,000. Of this total, the eastern counties, namely, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Bristol, Barnstable, Nantucket, and Dukes received nearly 92 percent of this total. Looking at Worcester, Middlesex, and Essex Counties, approximately 1 percent of the total is generated here which amounts to over $10 million. When this figure is adjusted to reflect regional boundaries, the Central Region generates nearly $5 million.

4.6 RELATIONSHIP BETWEEN ECONOMIC SITUATIONS AND NED SPECIFIC COMPONENTS

4.6A Land Use

The NED specific components are formulated to minimize the movement of agricultural land into other uses. Due to the higher incomes possible from alternative employments, agricultural land is decreasing because of low returns to the agricultural enterprise. This is a result of inter-regional competition, land prices, tenure and land holding philosophies, physical characteristics of the land (soils, slopes, growing season length, etc.) and marketing and processing infrastructure. It is obvious that a laissez-faire market policy is not conducive to the maintenance of agricultural land. Thus, a public policy which would either artificially (subsidize) or directly impact the agricultural market structure is necessary. To that end, the General Court of Massachusetts passed a Development Rights Act to preserve agricultural land, and then passed a measure providing state funds to acquire these rights. These programs could potentially lower entry costs, tax costs, and develop tenure and land holding philosophies that are more conducive to agricultural operations. The long term application of these programs, if adequately funded, should enhance the potential for economic growth of the agricultural marketing and processing infrastructure.

In discussing the forest land specific NED components, economic conditions preclude optimism for obtaining objectives. Like the agricultural land resource area, the forest land area suffers from some adverse economic conditions. This is due to inter-regional competition, tenure and land size holding patterns, reasons or philosophies for owning forest land, and minimal availability of primary, secondary, and tertiary wood processing firms. Thus, to attain the NED specific component of increased utilization of the forest resource, requires that an approach be formulated whereby forest land owners can see the "value" of increasing the utilization of the forest land resource.

4.6B Flooding

The specific NED objectives for flooding involves minimizing flood damages in the region by structural measures. Component measures include floodproofing existing property, guiding development away from flood-prone areas, and protecting wetland flood storage areas from filling or development. With the present economic situation and the present federal and state statutes, the attainment of the NED components is quite realistic.

4.6C Wetlands

The NED components for protecting the wetland resource areas consist of protecting wetland flood storage from filling, protecting flood-prone areas from development, and increasing wetland recreation. Like flooding, given present local, state, and federal statutes and present economic conditions attainment of the NED components is realistic.

4.6D Recreation

According to the state outdoor recreation report, the demand for recreation exceeds the available supply and thus, the NED specific component is to increase public access to outdoor recreation resources and to increase the recreational opportunities so that the difference between supply and demand will be minimized. From an economic perspective, attaining the NED components is not an unwarranted goal. Obviously, if present state financial problems were to continue to exist at the level of the past 3 years, the attainment would be slow. Thus, economically, the status of local and state finances will determine what proportions of the components are attained. A statute limits liability to those landowners who permit public access to their land for recreation use. The question is how much can the state afford to budget towards attaining the recreation objective.

4.7 ENVIRONMENTAL SITUATION

4.7A General Description of Topography

Landforms in the region are the result of glacial activity during the Pleistocene ice age. Topography varies from the slightly rugged hilly uplands of the west to the relatively flat lowlands in the east. The hills, streams and many wetlands left by the last glacial period are of great importance to the region.

Tourists are attracted to the region by the beauty of the seacoast, wooded hills and streams. Others enjoy the charm and peacefulness of small villages and quaint countrysides. During the summer months great numbers of people flock to the beaches, streams, and campgrounds to fish and boat, camp or picnic, and enjoy the beauty and outdoors.

4.7B Coastline and Tidewater

The Central Region has a relatively short saltwater shoreline. This coastal area is in the northeast corner of the region where the Merrimack reaches the ocean and is the northernmost saltwater coastline in Massachusetts. This area, though small, has important estuaries and tidal flats.

The Merrimack River due to its natural properties and unique location once supported great numbers of fish including shad and salmon. The Merrimack estuary including its intertidal area and the salt marshes which drain into it has an area of nearly 13 square miles. Pollution and misuse have reduced the river and its estuaries of their former greatness but still they support many types of fish as well as resident and migrant birds.

4.7C Wetlands

The region wetlands have also been a source of enjoyment to residents and visitors. The area has over 82,000 acres of inland wetlands which provide storage for floodwaters, maintain summer flows in the streams, serve as fish and wildlife habitat, and enhance visual quality. In the 1960s individuals and governments began to realize that wetlands were being lost at an alarming rate. Developers were buying parcels of cheap swampland, hauling in fill and constructing shopping centers and housing tracts, and then departing to let the new owners be confronted with the problems of high-water tables, settling and cracking foundations, failing septic systems, periodic flooding and a host of related nuisances. In addition, it became apparent that loss of natural flood storage in the wetlands was causing downstream flood peaks to increase, resulting in increased financial losses due to flooding. The loss of wetland wildlife habitat and its effect on certain species was not as dramatic as the other problems but was very real to knowledgeable observers.

In some cases, town governments themselves were unwitting co-conspirators in the loss of wetlands. Zoning regulations encouraged developers to build in many wetlands zoned for industrial or commercial uses. Some towns decided that these "useless swamps" would serve as good municipal dump sites. Similar problems with wetland losses occurred in the saltwater wetland areas. There, fill was being placed in prime wildlife breeding areas to provide more high value real estate.

To counter the loss of wetlands, pioneer legislation was introduced by Representative Francis Hatch. Even to this date, subsequent wetlands legislation is often referred to as "the Hatch Act" even though the original Hatch Act has seen many changes through the years. In addition to restriction laws, Massachusetts has a very active wetlands acquisition program. Two key state agencies involved are the Massachusetts

Divisions of Forests and Parks and Fisheries and Wildlife. Cities and towns are also involved in wetland acquisition. Cost sharing funds for such community acquisitions are provided from the Massachusetts Self-Help Fund (GL Ch. 132A, Sec. 11) administered by the Massachusetts Division of Conservation Services. The various wetland restriction, control, and conservation measures now available to protect wetlands are described in detail in Chapter 5.

4.7D Inland Water

The Central Region has over 39,900 acres of fresh open water in addition to the 82,000 acres of inland wetlands. There are over 1,380 miles of major streams and tributaries.

Streams in the region vary from low gradient, sluggish ones in the northeast to some relatively steep fast flowing streams in the west. Historically, development, especially industrial, has occurred along the streams. As populations and industry grew, the water quality of the streams deteriorated. Several low gradient sluggish streams with large wetland areas where flushing action is slow developed serious water quality problems. Presently water quality of streams and inland water is generally improving due to the efforts of the towns and industries and public concern of the problem.

Most inland water whether natural or man made reservoirs are relatively shallow. Many are less than 10 feet in depth with most of the deeper ones only 25 to 35 feet. An exception to this is Wachusett Reservoir, the largest body of water in the region which has a maximum depth of approximately 120 feet.

Surface water is used for local water supply in less than half of the towns in the region, and most of these also use ground water sources. Throughout the region and particularly in the southern part, ground water is the principal source of community water. The two major inland waters in the region are Wachusett Reservoir and Chaubunagungamaug Lake (Webster Lake). There are many additional sites for new surface reservoirs. These may be needed in the future for recreation and water supply. There appears to be a desire on the part of the people to insure that demands for adequate recreation facilities as well as municipal water be met by government.

4.7E Forest

Between 1951 and 1971 MacConnell's work shows an increase in urban land of 108,510 acres and a decrease in forest land of 6,760 acres.[10/]

Presently 338 acres of forest land are being lost each year while 5,400 acres of urban land are gained. In the past this urban development has

occurred primarily on farmland or open lands; however less farmland will be available in the future for development, thus urbanization of forest land will increase significantly. These land use changes not only affect the forest economy, but they also affect the environmental quality of the area.

The land use changes taking place in the region are decreasing the quality of the environment, and these changes are projected to continue, but at a declining rate in the future. There are ways to have urban expansion and also maintain a good environmental quality. This requires careful land use planning to incorporate the urban and forest environments.

4.7F Population Distribution and Land Use Aspects

The population within the Central Region amounted to 1,255,076 in 1975. With a total land area (excluding water and wetlands) of 1,092,056 acres, or 1,706 square miles, the population density was approximately 736 people per square mile (or 1.1 person per acre). Most of the population, as can be seen in Table 4.5, is concentrated in the Merrimack and the SuAsCo substudy areas. In the former, population density per square mile is equal to 1,290 persons, and in the latter, it is 835 persons per square mile. In terms of recent growth, the SuAsCo substudy area leads the list: 56.6 percent between 1950 and 1960, 44.08 percent between 1960 and 1970, and 58.26 percent between 1960 and 1975. Only one substudy area, the Blackstone, lost population between 1960 and 1975 and that amounted to 4,383 persons or a 1.59 percent loss.

It is important to note that from an environmental perspective, there appears to be enough water and related land resources to satisfy future resource demands without resulting in the degradation of environmental quality. Such results can only be achieved, however, if future growth is guided away from environmentally sensitive areas to those locations which can adequately accommodate future developments. Also required is an enactment of means whereby desirable growth forms are permitted. For example, most agricultural and forested land is zoned for low density residential. Such ordinances result in extensive developments which consume not only large acreage but also provide the vehicle for urban sprawl and increased service requirements. Therefore, if a regional goal is to preserve agricultural land, and if zoning ordinances are not modified to permit more intensive uses of land (e.g., cluster developments, planned unit developments, etc.), it is doubtful whether preservation goals can be obtained.

4.8 PROJECTIONS

4.8A Methodology (Projection Procedures and Relationship to OBERS)

General -- A major objective of the Massachusetts Water Resource Study is to project a number of important variables (land use, population,

TABLE 4.5 POPULATION, LAND AREA, AND POPULATION DENSITIES, 1950, 1960, 1970, 1975

Study Area	1950	1960	Percent Change 1950-1960	1970	Percent Change 1960-1970	1975	Percent Change 1960-1975
Merrimack							
Population	317,947	346,734	9.05	405,116	16.84	424,786	22.51
Land Area (ac)	210,711	210,711		210,711		210,711	
Densities							
Persons/acre	1.51	1.65	9.27	1.92	16.36	2.02	22.42
Persons/sq mile	966	1,053	9.01	1,230	16.81	1,290	22.51
Nashua							
Population	127,395	157,140	23.35	178,334	13.49	174,566	11.09
Land Area (ac)	293,949	293,949		293,949		293,949	
Densities							
Persons/acre	0.43	0.53	23.26	0.61	15.09	0.59	11.32
Persons/sq mile	277	342	23.47	388	13.45	380	11.11
Blackstone							
Population	266,578	261,549	-1.89	261,780	0.09	257,397	-1.59
Land Area (ac)	176,215	176,215		176,215		176,215	
Densities							
Persons/acre	1.51	1.48	-1.99	1.49	0.68	1.46	-1.35
Persons/sq mile	968	950	-1.86	951	0.11	935	-1.58
SuAsCo							
Population	130,662	204,613	56.60	294,803	44.08	323,816	58.26
Land Area (ac)	248,067	248,067		248,067		248,067	
Densities							
Persons/acre	0.53	0.82	54.72	1.19	45.12	1.31	59.71
Persons/sq mile	337	528	56.68	761	44.13	835	58.14
Thames							
Population	55,991	64,095	14.47	72,704	13.43	74,511	16.25
Land Area (ac)	163,114	163,114		163,114		163,114	
Densities							
Persons/acre	0.34	0.39	14.71	0.45	15.38	0.46	17.95
Persons/sq mile	220	251	14.09	285	13.55	292	16.33
Central Region							
Population	898,573	1,034,131	15.09	1,212,737	17.27	1,255,076	21.37
Land Area (ac)	1,092,056	1,092,056		1,092,056		1,092,056	
Densities							
Persons/acre	0.82	0.95	15.85	1.11	16.84	1.15	21.05
Persons/sq mile	527	606	14.99	711	17.33	736	21.45

Source: Population figures from Table 2.4. Land acreage from MacConnell et al.

income etc.) and thereby identify areas that may experience potential problems. Once potential problems are recognized, alternative policies can be developed which have as their objective, the minimization of such problems.

The growth of any region and the quality and quantity of its water and related resources are closely interrelated. This is obvious when it is considered that new development creates demand for water (drinking, recreation, waste disposal) and land which may result in an encroachment upon ecologically and economically sensitive areas (e.g., flood plains, wetlands, and lands overlying aquifers). Projections are utilized to determine the extent and rate of development (or the decline therein) and whether or not increased demands upon the resource base can be met with a set of projected resource suppliers (water, land, transportation, etc.). Problems arise to the extent that critical resources of minimum quality and quantity can satisfy or not satisfy such demands. For example, federal and state land use policies have placed a high priority on the preservation of agricultural land (specifically, prime agricultural land). In the past, much of the development in the region has been at the expense of agricultural and forest land. Given the priorities on preserving such land, future growth and land demand give an indication of what is likely to occur, given recent trends. Such forward looking procedures also indicate the extent to which future growth must be guided.

Some of the economic activity-type projections were taken from OBERS projections, Series E, and were then disaggregated to more closely approximate the boundaries of the Central Region.[19/] In using the OBERS projections, the intentions thereof are clearly described by the Director of Water Resources Council:

> The OBERS projections are intended as a planning tool, as a contribution to planning decisions. Wherever water and related land development problems may be solved by alternative levels of growth, through more or less resource development, full consideration should be given to such action, uninhibited by the projections contained in this report.
>
> The OBERS projections are not a goal. It is not intended that they be used as assigned shares, or quotas. They are not intended as a constraint on any region's economic activity. They do not express what is desirable or undesirable.[19/]

There are a number of assumptions utilized in the preparation of the OBERS Regional projections. These are specified in detail in Vol. I of the 1972 Series E OBERS. In some instances, these assumptions may or may not be to any one particular region. State and local planners

should compare those assumptions used in the formulation of the OBERS projections to determine which ones are applicable and the amount of adjustment needed to bring them into compliance with what exists in the region.

Population -- There were two population projections available for use in this study. The first was the OBERS projections developed by the Bureau of Economic Analysis and the Economic Research Service, and the second source was the Regional Planning Commissions located in the Central Region. Although the two projection sources suggested similar rates of growth, projections supplied by the Regional Planning Commissions were used in this study. The primary reason for this decision was three-fold:

1. The geographic configuration of the region presents many difficulties in accurately allocating various OBERS SMSA population data to the Central Region.

2. OBERS projections were developed using 1972 data whereas the various planning commissions used up-to-date information and more recent trends for their projection base.

3. National projections are disaggregated first to states, then to regions and finally to subregions.

For each disaggregation, the probability of error increases correspondingly.

Economic Projections -- Economic projections were taken from OBERS data as well as Office of State Planning Data. Historical and projected economic data were gathered for the Boston and Worcester-Leominster-Fitchburg SMSA's and were adjusted to reflect the boundaries in the Central Region. The adjustment factors were computed using economic data supplied by the Massachusetts Department of Commerce and Development in city and town monograph publications. In view of the fact that two different sources of data were used, complete uniformity was impossible. However, the direction and velocity of identifiable trends are more relevant considerations than simply the absolute numbers. In this light, the fact that there may not be consistent and uniform comparisons should not detract from the validity of the analysis.

Land Use Projections -- A number of methodologies were utilized to project the various land use categories. Agricultural land was projected by using historical agricultural land data which were compiled from the 1949, 1954, 1959, 1964, 1969, and the 1974 Census of Agriculture. The historical land use data was weighted heavier in the latter years of the data set (1964 through 1974) to more accurately reflect recent trends. In some cases, it was necessary to allocate data from those counties which were located in more than one study region to the particular area

included in the Central Region. For example, Essex County is in two regions--the Central and the Coastal. Middlesex is also in both regions. In addition, portions of Worcester County are in the Central as well as in the Connecticut Region. The allocation was accomplished by using MacConnell's Land Use Data to first determine the amount of agricultural land by category in each town in each respective region. Once these proportions were computed, they were then used to adjust the County Census data to reflect that data located in each of the various regions. After the adjusted census data were enumerated for each substudy area, a Markov probability program was used to project the 1990 shares that each agricultural land use category would contribute to the total land in farms. The total land in farms on the other hand was computed using two different methodologies: OBERS, Series E Report projections; and developing another Markov probability program. Each of these projected totals were then multiplied times the projected 1990 shares each agricultural land use category contributes to that total. It should be noted that the OBERS total land in farms projection is significantly higher than the Markov projection. This difference can be attributed to the methodology utilized in the OBERS projection, and the fact that the Markov program is based solely upon historical relationships.

The State OBERS projections are based upon a National projection which was first disaggregated to a regional basis, and then disaggregated further to generate the state projections. On a National basis, recent trends in agricultural land have shown a leveling off in agricultural land declines. Consequently, this leveling off was reflected in both the Regional and the State disaggregations. As a result, especially with respect to Massachusetts, the leveling off aspect resulted in a much more optimistic projection than that suggested by the Markov probability projection. The Markov method may be considered the more pessimistic projection simply because it heavily weights the recent trends of agricultural decline.

Urban land was projected by using a log-linear regression model that was run on MacConnell's data. For the purposes of this study, urban land was defined as industrial-commercial, residential, and institutional (schools, hospitals, etc.). Share of urban land by town and population density variables was aggregated to the substudy area level. A number of regression equations were formulated and regressed. The "best" equation was utilized to project urban land acreage to 1990. In addition to MacConnell's Urban Land Use data, population projections supplied by the various planning commissions in the region were also used. The population density model tied together with historical urban land acreage was found to "fit the best." Base year data for 1951 and 1971 were used to estimate the regression coefficients for the entire Central Region. Similar regressions were also calibrated by substudy area to reveal regional differences. Weighted aggregations of these coefficients by region and by substudy area for 1951 and 1971 were used in the final

regression model to project urban land use by subregion for 1990. The regression model used is simple and requires a minimum of input data. In addition, changing assumptions such as future population growth rates or per capita demand for land would require only simple adjustments to the model parameters and/or the data base.

Projected area for open water in 1990 is considered to be approximately the same as the 1971 figure of 38,956 acres since no large future water impoundment projects are under consideration between now and 1990.

Wetland projections to 1990 were based on historical trend analysis and adjusted to reflect the Wetland Restriction Acts presently in force in Massachusetts. Based on these factors, it was estimated that wetlands would decrease at the rate of .4 percent per year through 1990.

Forest land was projected by adjusting MacConnell's Land Use data to exclude forest land on farms and wooded wetlands identified by the Soil Conservation Service in 1976. Forest land on farms and wooded wetlands were subtracted from the 1971 forest land acreage because these two categories of land use are projected in the agricultural land projections and the wetland projections respectively. The final projection dealt with the "other" land category, and was projected as being the residual from all other acreage in the above land use categories.

4.8B Population and Economic Projections

Population -- Population projections gathered from the various Regional Planning Commissions in the Central Region show population increasing in all regions through 1990. At that time the regional population is expected to be approximately 1,485,257 people, an increase of 230,181 or nearly 18.4 percent greater than the 1975 population of 1,255,076. Thus, there will be an average 6.13 percent increase in population every 5 years.

Although direct comparisons with OBERS projections are not possible in terms of absolute numbers, similar rates of growth are projected. Whereas the various regional planning commissions have projected a change of 22.5 percent between 1970 and 1990, OBERS projections amount to 22.3 percent for the same period. Although the rates of growth are similar for each of the two projection sources, where available the figures utilized in this report are those from the Regional Planning Commissions because of the following characteristics of the OBERS population projections:

1. The geographic configuration of the region presents difficulties in accurately allocating the various OBERS SMSA population data through the region.

2. OBERS projections were developed using 1972 data whereas the various planning commissions are using more up-to-date information and more recent trends.
3. The OBERS projections are disaggregated National projections, first to states, then to regions, and finally to subregions. For each disaggregation the probability of error increases correspondingly.

Table 4.6 summarizes the population projections for the Central Region.

TABLE 4.6 POPULATION PROJECTIONS, 1975-1990, WITH PERCENTAGE CHANGES

Substudy Area	1975	1980	1985	1990
Merrimac	424,786	455,726	483,858	509,369
Nashua	174,566	191,597	202,502	212,924
Blackstone	257,397	262,622	266,142	269,652
SuAsCo	323,816	354,547	380,048	402,573
Thames	74,511	82,522	86,665	90,739
Total	1,255,076	1,347,014	1,419,215	1,485,257
	- - - - - - - - Regional Changes - - - - - - - -			
Years	1975-1980	1975-1985	1975-1990	
Change	91,938	164,139	230,181	
% Change	7.32	13.08	18.34	

Source: Regional Planning Commissions.

Economic Projections -- The relative changes between 1950 and 1970 are expected to continue between 1975 and 1990. For example, manufacturing earnings in 1975 were $1,133,252,628. In 1990, these earnings are expected to increase to $1,616,365,542. The service related industries (finance, insurance, real estate, services and government) are expected to increase from $1,541,978,934 in 1975 to $3,403,479,424 in 1990.[20/]

As can be seen in Table 4.7, the service-related enterprises are expected to increase 137 percent above their 1975 level by 1990. Looking at the total economic picture, total earnings are expected to increase by slightly more than $3.1 billion or an 81 percent gain.

TABLE 4.7 POPULATION, EMPLOYMENT/POPULATION RATIO & EARNINGS BY INDUSTRY, 1975, 1980 and 1990

		Merrimack	SuAsCo	Blackstone	Nashua	Thames	Total
Population, midyear		424,786	323,816	257,397	174,566	74,511	1,255,076
Employment population ratio		.37	.39	.49	.35	.31	.39
(X 1,000 1967 $)							
Agriculture, forest mining & fisheries	1975	6,196	4,829	5,916	2,879	1,104	20,922
	1980	7,057	6,045	6,451	3,096	1,282	23,930
	1990	8,056	7,493	6,300	3,375	1,448	26,672
Contract construction	1975	87,618	70,065	50,410	24,531	9,405	242,030
	1980	105,739	90,577	58,527	28,083	11,631	294,558
	1990	146,898	136,634	73,008	39,114	16,782	412,436
Manufacturing	1975	323,729	258,875	329,101	160,151	61,398	1,133,253
	1980	366,475	313,927	358,209	171,881	71,186	1,281,678
	1990	467,521	434,856	404,383	216,649	92,955	1,616,366
Transportation, communications & utilities	1975	91,458	73,136	51,721	25,169	9,649	251,133
	1980	111,524	95,533	63,026	30,242	12,525	312,850
	1990	161,858	150,549	80,274	43,007	18,452	454,140
Wholesale & retail trade	1975	234,477	187,504	125,602	61,122	23,433	632,138
	1980	276,066	236,481	156,738	75,208	31,148	775,641
	1990	370,831	344,922	195,370	104,670	44,910	1,060,703
Finance, insurance and real estate	1975	99,687	79,717	39,887	19,410	7,441	246,143
	1980	123,502	105,793	51,567	24,744	10,248	315,853
	1990	181,167	168,509	68,872	36,899	15,832	471,278
Services	1975	300,808	240,546	148,158	72,098	27,641	789,250
	1980	424,637	363,749	199,137	95,553	39,574	1,122,651
	1990	697,638	648,895	297,326	159,293	68,346	1,871,498
Government	1975	185,509	148,345	103,235	50,237	19,260	506,586
	1980	244,320	209,287	125,755	60,342	24,991	664,695
	1990	369,602	343,779	170,789	91,501	39,259	1,014,930
Total	1975	1,329,482	1,063,016	854,030	415,598	159,330	3,821,455
	1980	1,659,319	1,421,391	1,019,410	489,149	202,586	4,791,856
	1990	2,403,571	2,235,637	1,296,323	694,507	297,985	6,928,023

Source: OSP employment projections and earnings, from OBERS Projections

Employment projections indicate that manufacturing earnings will have the greatest decrease in percent of total employment earnings, while service will increase the most. The present and projected distribution of employment earnings, by percent, are shown in Table 4.8.

TABLE 4.8 EMPLOYMENT EARNINGS (PERCENT DISTRIBUTION, SIC) 1975-1990

	1975	1980	1990
Agriculture, Forestry, Fishing and Mining	0.5	0.5	0.4
Construction	6.3	6.1	6.0
Manufacturing	29.7	26.7	23.3
Transportation, Utilities, Commodities	6.6	6.5	6.6
Wholesale, Retail Trade	16.5	16.2	15.3
Finance, Insurance, Real Estate	6.4	6.6	6.8
Service	20.7	23.4	27.0
Government	13.3	13.9	14.6

Source: Massachusetts Office of State Planning and OBERS Projections.

In reference to the objectives of the study, the question must be asked, how will or how might the expected economic and social trends affect the region's water and related land resources? And this question can be answered by determining what new demands will be placed on these resources. Given the present amounts of nondeveloped land, excluding environmentally sensitive lands, with proper land use guidance, the overall growth, both economic and social, can be satisfied with the region's water and related land resources.

OBERS projected potential need for wood product production is 6.4 million cubic feet by 1980 and 7 million cubic feet by 1990. OBERS estimates are based on the total commercial forest land acreages and land productivity.

4.8C Land Use Projections

Agricultural Land -- As discussed in 4.7A a number of methodologies were utilized to project various land use categories to 1990. These

categories are as follows:

1. Agricultural land
    a. Total cropland
        (1) harvested cropland
        (2) pasture/grazing cropland
        (3) all other cropland
    b. Forest land
    c. All other farmland
    d. Total land in farms
2. Urban land
    a. Industrial-commercial land
    b. Institutional land
    c. Residential land
3. Open water areas
4. Wetlands
5. Forest land
6. All other land

As Table 4.9 reflects, there are significant differences in the two projection techniques. For reasons discussed in Section 4.5A, the OBERS projection should be considered the optimistic projection and the Markov projection should be considered the pessimistic projection. In other words, the data reflected on Table 4.9 should be considered the range of probable agricultural land acreage in 1990.

TABLE 4.9 AGRICULTURAL LAND USE, BY ACRES, 1974-1990, USING OBERS AND MARKOV PROBABILITY PROJECTION TECHNIQUES

	1974 (acres)	1990 OBERS (acres)	1990 MARKOV (acres)	Differences between two projections
Total Cropland	61,626	54,688	32,524	22,164
Harvested cropland	45,695	41,919	24,930	16,989
Pasture/grazing cropland	12,632	9,697	5,767	3,930
All other cropland	3,297	3,072	1,827	1,245
Woodland on Farms	51,921	37,955	22,573	15,382
All Other Farmland	23,307	21,587	12,839	8,748
Total Land in Farms	136,853	114,230	67,936	46,294

What projection technique should be utilized? Given the methodology used in the OBERS report and the multitude of assumptions contained therein, the Markov technique more accurately reflects the trends that have recently occured in the Central Region. Such a projection suggests a precipitous decline in agricultural land amounting to 68,917 acres (or a 50.36 percent decline) between 1974 and 1990. Using the OBERS Projection, the trend suggests a decline of 22,623 acres (or 16.5 percent). Given the dynamics of land use change, especially for a category which is declining at such a rapid rate the intensity of use on such land usually increases. As the intensity increases, the value of production increases which, theoretically at least, would suggest a decreasing rate of decline. Thus, the Markov agricultural land projection should be considered as the more pessimistic projection. Given the recent trends in agricultural land use decline, it appears that the actual 1990 agricultural land acreage will, however, be closer to the Markov than to the OBERS figure.

The recent passage of bills to allow for public purchase of development rights may have a positive impact upon the retention of agricultural land. As the development rights to a particular farm are purchased by the public, value of the farmland would then decrease from the market-development potential to a value derived from its agricultural production potential. As a result, the largest barrier to entry, namely the high cost of land would decrease substantially. In addition, taxes which were formerly derived from marketvalue assessments would then be assessed on the agricultural value, and as a result, the cost of ownership would decrease. Further, "A supply of land from which development rights had been removed would create a 'market' for farmland at farm supportable prices in which a farmer who needed it could buy land to bring his operation to a more (economically viable) size."21/

Urban Land -- The projected urban land area for the entire Central Region is expected to amount to 276,051 acres by 1990. With respect to the substudy areas, the following projections are noted: Merrimack, 77,896; Nashua, 43,875; Blackstone, 44,079; SuAsCo, 84,191; and Thames, 25,380. The percent changes between 1970 and 1990 are 40.7, 38.6, 32.9, 60.8, and 84.5, respectively.

Translating these percentages to the Central Region area, it is expected that a 48.2 percent increase (or an increase of 89,773 acres) in urban land will occur by 1990. Thus, wherein 1970 urban land was approximately 17.1 percent of the total Central area, by 1990 it is expected to amount to 25.3 percent.

Water -- The 1990 projection for open water area is expected to remain approximately the same as the 1971 figure of 38,956 acres.

Wetland -- Wetland projections to 1990 suggest that there will be approximately 77,429 acres in this category. This amounts to a decline of 4,590 acres for a total decline of slightly more than 5 percent (or .4 percent annually) between 1970 and 1990.

Forest land -- 550,803 acres of forest land (excluding wooded wetland and woodland on farms) is expected by 1990. Adjusting MacConnell's 1971 figure to exclude woodland on farms and wooded swampland, results in a figure of 556,259 acres. Thus, there is an expected decline of 5,456 acres (0.98 percent).

Other Land -- The final projection dealt with the "other" land category. This category was projected as being the residual from all other acreage in the above land use categories. The 1990 OBERS projection amounts to 34,587 acres or a decline of 57,104 acres representing a 62.28 percent loss. The 1990 Markov projection, however, calls for a figure of 80,881 acres representing a loss of 10,810 or a decline of 11.8 percent. The increase over the OBERS other land projection reflects the additional acreage available resulting from the Markov agricultural land projection. Table 4.10 summarizes the OBERS and Markov 1990 land use projections.

TABLE 4.10 LAND USE CHANGE, BY ACRES, 1971-1990, USING MARKOV AND OBERS PROJECTION TECHNIQUES

		1990		Change 1971-1990		Percent Change	
	1971	OBERS	MARKOV	OBERS	MARKOV	OBERS	MARKOV
Agricultural Land	136,853 1/	114,230	67,936	-22,622	-68,917	-16.53	-50.36
Water	38,956	38,956	38,956	--	--	--	--
Wetland	82,019 2/	77,429	77,429	-4,590	-4,590	-5.6	-5.6
Forest	556,259	550,803	550,803	-5,456	-5,456	-0.98	-0.98
Urban	186,278	276,051	276,051	89,773	89,773	48.19	48.19
Other	91,691	34,587	80,881	-57,104	-10,810	-62.28	-11.8
Total	1,092,056	1,092,056	1,092,056	--	--	--	--

1/ Agricultural Land acreage is for 1974.
2/ Wetland acreage is for 1976.

NOTES

1/ City and Town Monographs - Massachusetts Department of Commerce and Development.

2/ Historical population figures were gleaned from town monographs (revised in July, 1973) published by the Massachusetts Department of Commerce and Development, Boston, Massachusetts. Projections were taken from population figures developed by the Regional Planning Commissions in the region.

3/ OBERS is an acronym for the Office of Business Economics (OBE--presently named Bureau of Economic Analyses, U.S. Department of Commerce) and the Economic Research Service (ERS--presently named Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture).

4/ Information garnered from Massachusetts Department of Commerce and Development Town and City Monographs, 1975. National per capita income was taken from U.S. Department of Commerce, Bureau of Economic Analyses, Local Area Personal Income.

5/ Agricultural Preservation--Massachusetts General Laws, Chapter 232 and 780 of the Acts of 1977.

6/ 1974 Census of Agriculture, Volume I, U.S. Department of Commerce. Social and Economic Statistics Administration, Bureau of the Census, Washington, D.C., April 1977.

7/ It should be noted that probably a large proportion of these farms are either part-time enterprises or enterprises which seek to accrue tax advantages. With the 1976 National Tax Acts, however, tax benefits over the near future will not be as large as they once were. Thus, one could expect that such enterprises would either be sold or simply not defined as farms in future censuses.

8/ A Policy for Food and Agriculture in Massachusetts, Executive Office of Environmental Affairs, Department of Food and Agriculture (Boston: 1967), p. 6.

9/ Christensen, Robert L., John H. Foster, and Donald R. Marion, Self-Sufficiency for Food in Massachusetts (Part II), Cooperative Extension Service, University of Massachusetts, U.S. Department of Agriculture and County Extension Services Cooperating (Amherst, Massachusetts) 1976.

10/ MacConnell, William P., William Niedzwiedz, Remote Sensing 20 Years of Change in Worcester County, Massachusetts 1951-1971, Research Bulletin Number 625, Massachusetts Agricultural Experiment Station, Amherst, Massachusetts, November 1974 and similar publications by MacConnell et al., for Middlesex County and Essex County, (MacConnell Land Use Data).

11/ Bones, James T., 1973, "Primary Wood Product Industries of Southern New England," USDA, Forest Service, Resource Bulletin NE-30. Updated to 1976 through interviews with Massachusetts Service Foresters.

12/ NARWRCC, 1972, North Atlantic Regional Water Resources Study, Appendix C, Climate, Meteorology and Hydrology.

13/ From interviews with Massachusetts Service Foresters.

14/ Shaw, Samuel and David Gansner, A paper on "Incentives to Enhance Timber and Wildlife on Private Forest Lands," 1976.

15/ Massachusetts Division of Conservation Services, Massachusetts Outdoor Recreation Plan, Boston, Massachusetts, 1973 and interviews.

16/ Directory of Commercial Sawmill Operators and Loggers in Massachusetts, 1975. Cooperative Extension Service, University of Massachusetts.

17/ Massachusetts Industrial Directory 1974-75, Massachusetts Department of Commerce and Development, Boston, Massachusetts.

18/ Department of Hotel, Restaurant and Travel Administration, University of Massachusetts at Amherst, The Economic Impact of Tourism on the Commonwealth of Massachusetts, prepared for the Department of Commerce and Development, State of Massachusetts (Amherst, Massachusetts, December 1974), p. 1.

19/ 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E, U.S. Water Resources Council, Washington, D.C., 1974.

20/ 1972 OBERS Projections, and Massachusetts Office of State Planning.

21/ To Save the Farms, Benefits from Farmland, Interim Report of the Agricultural Land Preservation Committee, October 1976, p. 5.

CHAPTER 5

RESOURCE BASE
and
EXISTING PROGRAMS

5.1 RESOURCE BASE

5.1A General

The Central Region, approximately 1,706 square miles, lies between the Coastal Region and Connecticut River Region. It includes parts of three river basins, the Merrimack, Thames, and Blackstone. The Merrimack River lying within Massachusetts flows generally northeast directly into the Atlantic Ocean, and drains most of the northern two-thirds of the region. The upper reaches of the Thames and Blackstone Rivers drain the remaining southern one-third of the region. These two rivers flow in a southerly direction with the Thames River flowing through Connecticut into Long Island Sound and the Blackstone River through Rhode Island into Narragansett Bay. Little attention is focused here on the coastal shoreline as it effects only a few towns in the northeast where the Merrimack River flows into the Atlantic Ocean.

For the purpose of this study the Merrimack River has been divided into three (3) subdrainages. These three along with the other two rivers make up the five Study Areas used in this report. Major streams within each Study Area are shown below.

Study Area	Major Streams
Merrimack	Merrimack River Shawsheen River
SuAsCo	Assabet River Concord River Sudbury River

Study Area - cont.	Major Streams
Nashua	Squanacook River Nashua River Stillwater River Quinapoxet River Nissitissit River
Blackstone	Blackstone River Kettle Brook Quinsigamond River Mill River Mumford River
Thames	Quinebaug River French River

The Central Region consists of 79 cities and towns. It is comprised of portions of Worcester, Middlesex, Essex and Hampden Counties.

The region is generally inland from the heavily populated coastal areas. Town population densities, based on 1970 U.S. Census, range from a high of 9,092 persons per square mile in the highly urbanized city of Lawrence to a low of only 41 persons per square mile in Holland. There are four cities or towns with population densities over 2,000 persons per square mile and eight towns with 100 or less persons per square mile.

Region boundaries were originally selected based on the hydrologic watershed boundaries as being natural dividing lines for a study of water and related land resources. Because of the importance of municipal governments in planning and implementing measures in Massachusetts, it was decided to adjust the hydrologic region boundaries so that all of a town's area could be assigned to one region. Those towns included in the Central Region are shown on Figure 1.1.

5.1B Soils of the Central Region

The soils of the Central Region have formed in materials influenced by glaciation. The region's many upland hills, drumlins and ridges are covered with 2 or 3 feet of friable loamy material underlain by firm, loamy or sandy heterogenous glacial till. Stones and boulders are normal surface features in wooded areas. Bedrock outcrops are especially common on steeper slopes.

Intermingled with the uplands, in valleys and lower positions, are soils formed in materials influenced by glacial meltwater. These areas range from nearly level to moderately steep with shorter slope lengths than the nearby upland hills. Soils in these areas are quite varied, but all have substrata of sand or sand and gravel. The surface soil and subsoil portions may be silty, loamy or sandy and contain varying amounts of gravel.

Minor areas in the northeastern part of the region include beaches, sand dunes and soils formed in old clayey lake and marine deposits.

The General Soil Map for the Central Region is on Figure 5.1. Five broad groups, or associations, of soils are indicated. They are discussed below.

1. Paxton-Hollis-Canton association -- The soils in this association formed in glacial till deposits. They occupy gently sloping to steep land forms of drumlins and ridges throughout the uplands of the region. These soils have fine sandy loam surfaces. The surfaces of wooded areas often have many scattered stones and boulders. Bedrock outcrops are common in some areas, primarily on the steeper slopes. These soils are well drained to excessively drained and are free of problems associated with soil wetness.

   This association is dominated by three major soils. The Paxton soils have loamy, slowly permeable substrata. They make up about 50 percent of the association. The shallow to bedrock Hollis soils constitute about 15 percent. The Canton soils have permeable sandy substrata and make up about 10 percent of the association. The remaining 25 percent of the association consist of numerous minor soils.

2. Hinckley-Windsor-Muck association -- The soils in this association formed in water sorted materials, primarily glacial outwash, and in pockets of organic materials. They are generally in the valleys on nearly level to rolling terraces, deltas, kames and eskers. Numerous areas of this association are suited for agriculture. Many soils in this group are free of water table problems and in fact are limited by drouthiness. Muck soils unless drained are too wet for most crops.

   This association is dominated by three major soils. The permeable Hinkley soils have sandy or sandy and gravelly substrata. They constitute about 40 percent of the association. The Windsor soils have sandy subsoils and are also very permeable. They make up about 30 percent of the unit. The wet or muck soils make up about 10 percent of the area. A number of other soils minor in extent make up the remaining 20 percent.

3. Dune land-Tidal marsh-Beaches association -- This group is very minor in the region, occuring only in a small area near the ocean. The association consists of ocean-washed beaches, the adjacent deep, sandy, rolling dunes and tide indurated salt grass flats. The salt grass tidal marsh is behind the dunes and extend inward along the streams. These areas are used primarily for wildlife and recreation. The dunes are only partially vegetated due to the wind action off the ocean.

SCS PHOTO'S

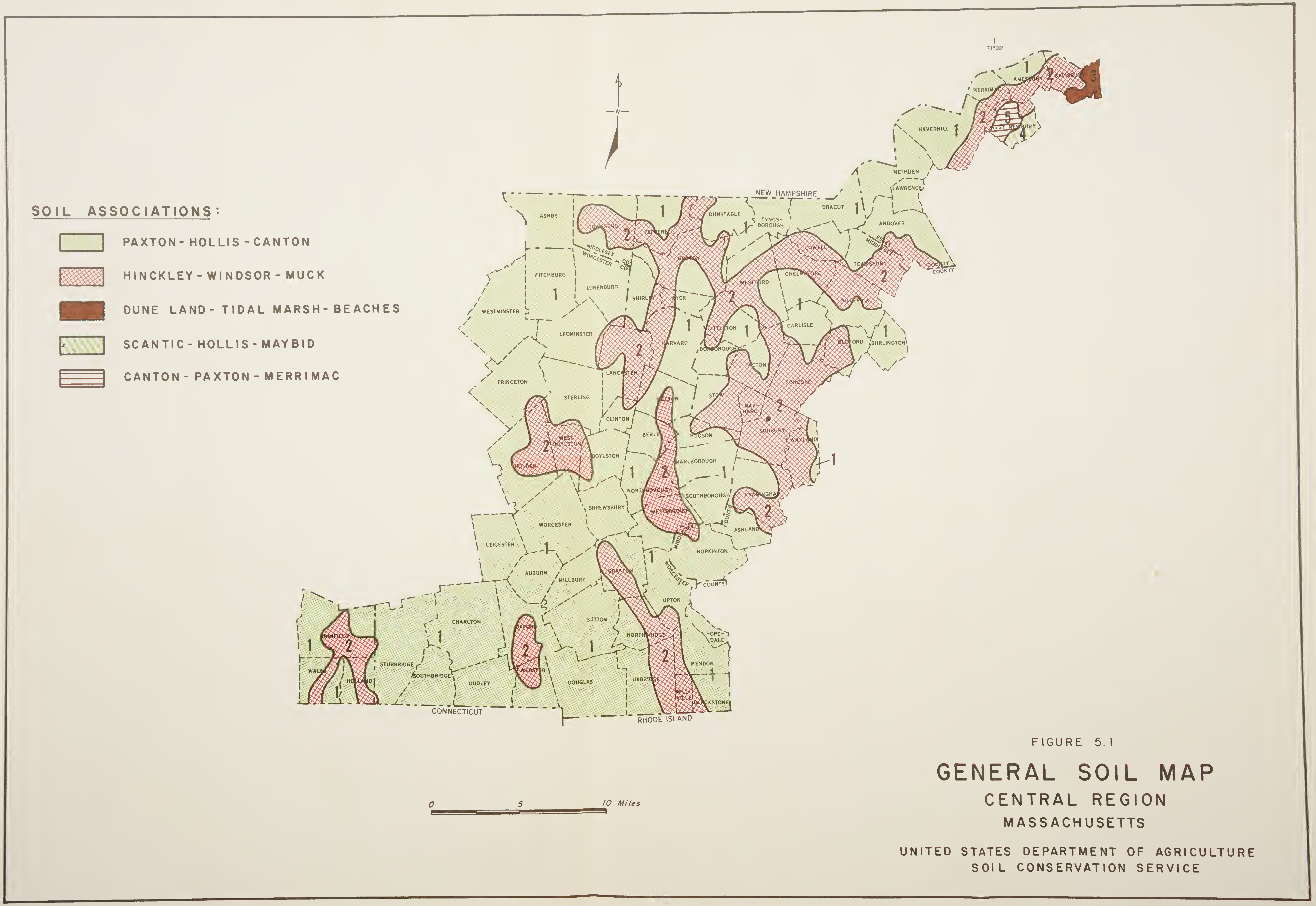

FIGURE 5.1

GENERAL SOIL MAP

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Three types of land are dominant in this association. Dune land makes up about 40 percent of the area. The wet tidal marsh, formed in thick accumulations of partially decomposed plant remains, comprise 35 percent of the association. The barren beaches constitute about 10 percent of the area. Other minor soils comprise the remaining 15 percent of the association.

4. Scantic-Hollis-Maybid association -- The soils in this association formed in clayey lake, or marine deposits. This association is a minor part of the Central Region. The soils are predominantly on nearly level flats in the extreme northeastern part of the region. These are primarily poorly or very poorly drained, slowly permeable, clayey soils. Bedrock outcrops are common in some areas. Wetness and restricted permeability are problems for most uses of these soils.

   The Scantic, Hollis and Maybid soils are dominant in this association. Hollis soils are shallow to bedrock, but Scantic and Maybid soils are deep to rock. Scantic soils make up about 40 percent, Hollis soils about 20 percent and Maybid soils another 20 percent of the area. Other minor soils comprise the remaining 20 percent of the association.

5. Canton-Paxton-Merrimac association -- This association consists of soils formed in glacial till as well as soils formed in water sorted glacial outwash. These contrasting materials are closely intermingled in a small area in the northeastern part of the region. These soils are on nearly level to undulating terraces and gently sloping to moderately steep upland ridges. They have fine sandy loam surfaces. Wooded areas of the Canton and Paxton soils often have surface stones, and bedrock outcrops are in some areas. The lower slopes of all these soils are suited to agriculture. They are all well drained so soil wetness is not a problem. The Canton and Merrimac soils have permeable sandy substrata. Paxton soils have compact slowly permeable substrata.

   Three soils dominate this association. It is comprised of about 50 percent Canton soils, 20 percent Paxton soils and 20 percent Merrimac soils. Other minor soils make up the remaining 10 percent.

5.1C Geology

The Central Region includes portions of three sections of the New England Physiographic Province. They are, in a west to east direction, the New England upland section, the seaboard lowland section, and a small bit of the New England shore section. Accordingly the topography varies from slightly rugged and hilly in the west to relatively flat and low lying in

the east. A close scrutiny of topographic details reveals a variety of landforms related to glaciation during the Pleistocene Epoch.

Various types of igneous, metamorphic and sedimentary bedrock occur in the Central Region. The geographic location and extent of any given rock type is often difficult to predict. The bedrock is generally hard and water tightness usually increases with depth. Water-bearing broken zones may occur in the uppermost several feet of the bedrock. Yields in bedrock wells usually are relatively low, and are adequate for only one or two families from a given well. An important body of granitic rocks exists in a line roughly running between Worcester and Lowell. These granites are still quarried for use as dimension stone.

Most of the unconsolidated deposits in the region owe their origin to the Pleistocene glaciation. Glacial till, consisting of a mixture of silt, sand, gravel, and boulders, occurs on the crests and flanks of the higher hills where bedrock is not exposed at the ground surface. Elsewhere, the till is often present in the subsurface beneath other unconsolidated deposits. The till is not a good source of sand and gravel due to its muddy and stony nature. However, it is an excellent source when relatively watertight soil is required for example, in a dam embankment. Water wells in till generally have a low yield.

When the glaciers melted, sand and gravel were deposited by the resulting streams. The deposits have a wide variety of topographic shapes, including outwash plains, terraces, sinuous ridges, and clusters of small hills. These deposits are best developed where the glacial deposits have filled preexisting valleys in the bedrock. Such areas have a high potential for ground water supply. The sand and gravel are quarried throughout the Central Region, including some relatively large washed sand and gravel operations.

The relatively wide, flat areas in the major river valleys are underlain by deposits of silt, sand, and clay. These areas are the sites of ancient lakes, formed when blocks of ice and other debris from the melting glaciers temporarily formed dams on the rivers.

Several earthquakes have been reported in the Central Region. In general, the seismic risk increases from moderate in the west to high in the east. The northeastern corner of the region is a part of one of the most seismically active zones in eastern North America. Some damaging earthquakes have been associated with this zone. Therefore, serious consideration should be given to earthquakes during design of engineering works, especially when foundations are in unconsolidated deposits.

5.1D Vegetative Cover

Approximately 83 percent of the region is in nonurban uses. Forest land

is by far the most dominant with 664,505 acres comprising 61 percent of the total land area. Hardwood forest is the dominant forest vegetation type; approximately two-thirds of the forest volume is in hardwoods. The major hardwood species are red oaks and soft maples. The major softwood species is white pine. The remainder of the nonurban land can be divided into cultured lands with agricultural crops including grasses and legumes and noncultured land. Wetlands and transitional lands such as abandoned fields and orchards are the major examples of the noncultured lands. If left alone, the transition lands will ultimately revert to forest through natural plant succession.

5.1E Climate

The average annual temperature is about 49° Fahrenheit (°F). Averages vary depending on the elevation, slope and other environmental aspects. Temperatures have been recorded below minus 30°F to highs of over 105°F. The growing season (frost-free period above 32°F threshold) averages from 140 to 160 days. Mean annual precipitation is about 44 inches and is rather evenly distributed throughout the year. Snowfall averages from 50 to 60 inches. Topography has a marked influence on snowfall causing much variation in short distances. The average annual runoff is about 22 inches or about one-half of the annual precipitation. See Figures 5.2, 5.3, 5.4, Climatological Data.

5.1F Storms and Droughts

Major storms have occurred in nearly every month of the year. "Northeasters" are one of the most serious storms. They generate very strong winds and heavy rain or snow. In winter these storms produce the heaviest snow, and during fall and spring are one of the more frequent causes of flooding. Some of the severest floods have been those associated with hurricanes or storms of tropical origin in late summer or early fall. The more significant flood producing storms of this century were the hurricanes of September 1938, August 1955 and September 1960, and the nonhurricane storms of November 1927, March 1936, November 1953, March 1963 and March 1968.

Droughts have occurred in the region with the longest in recent memory extending from 1962 to 1967.

Stream gage data from U.S. Geological Survey Stations throughout the region is abstracted in Table 5.1.

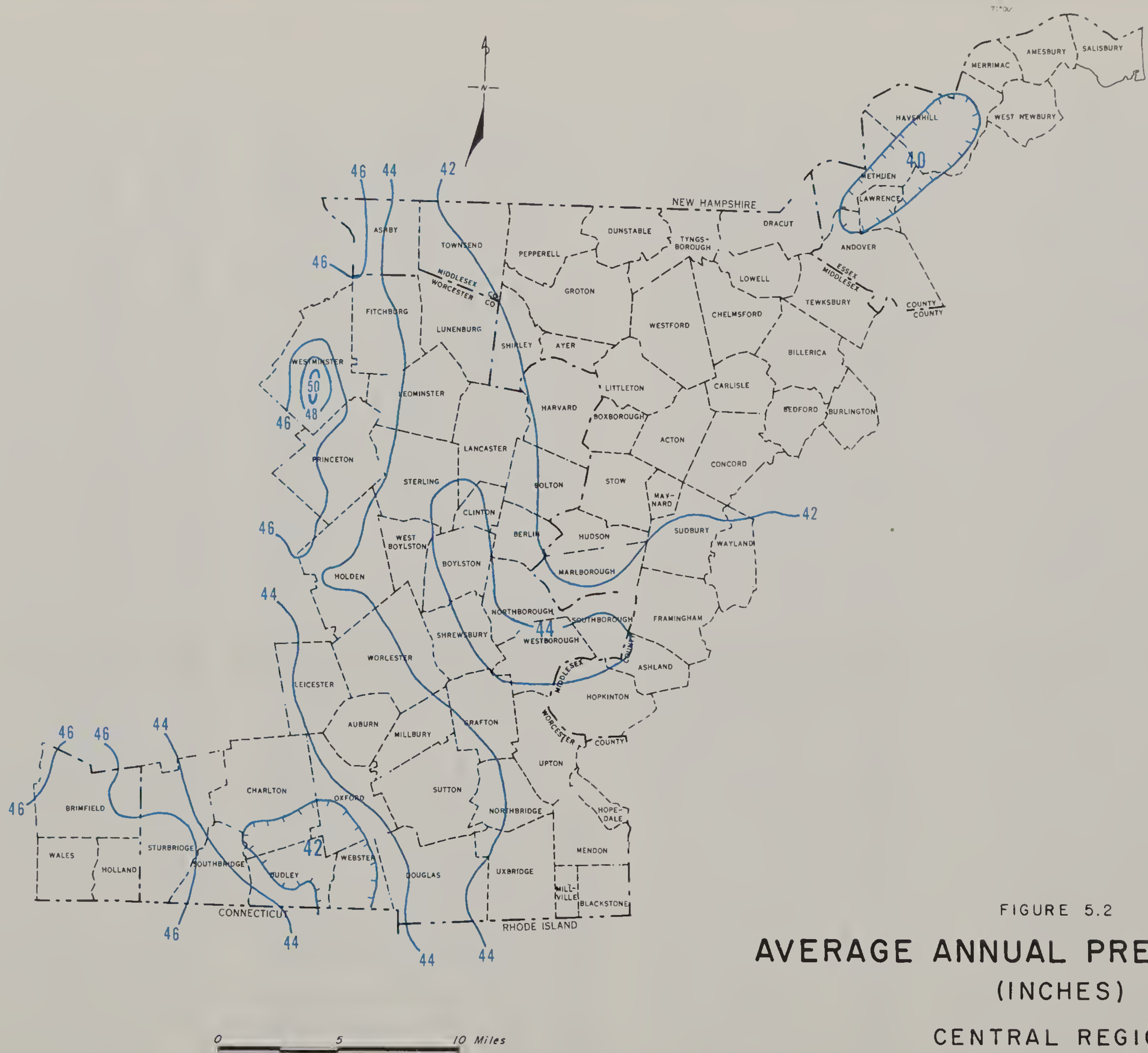

FIGURE 5.2

AVERAGE ANNUAL PRECIPITATION
(INCHES)

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

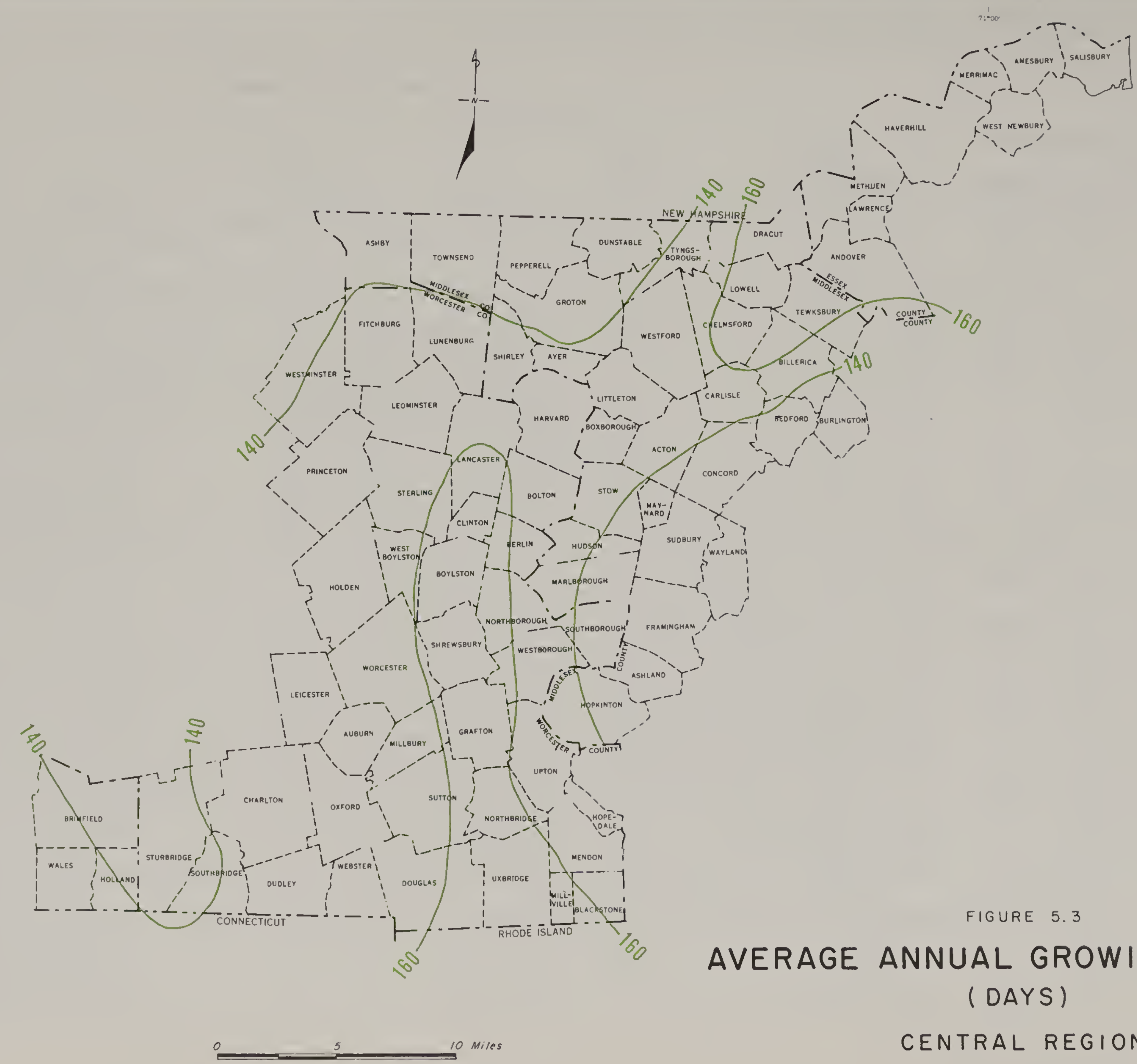

FIGURE 5.3

AVERAGE ANNUAL GROWING SEASON
(DAYS)

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

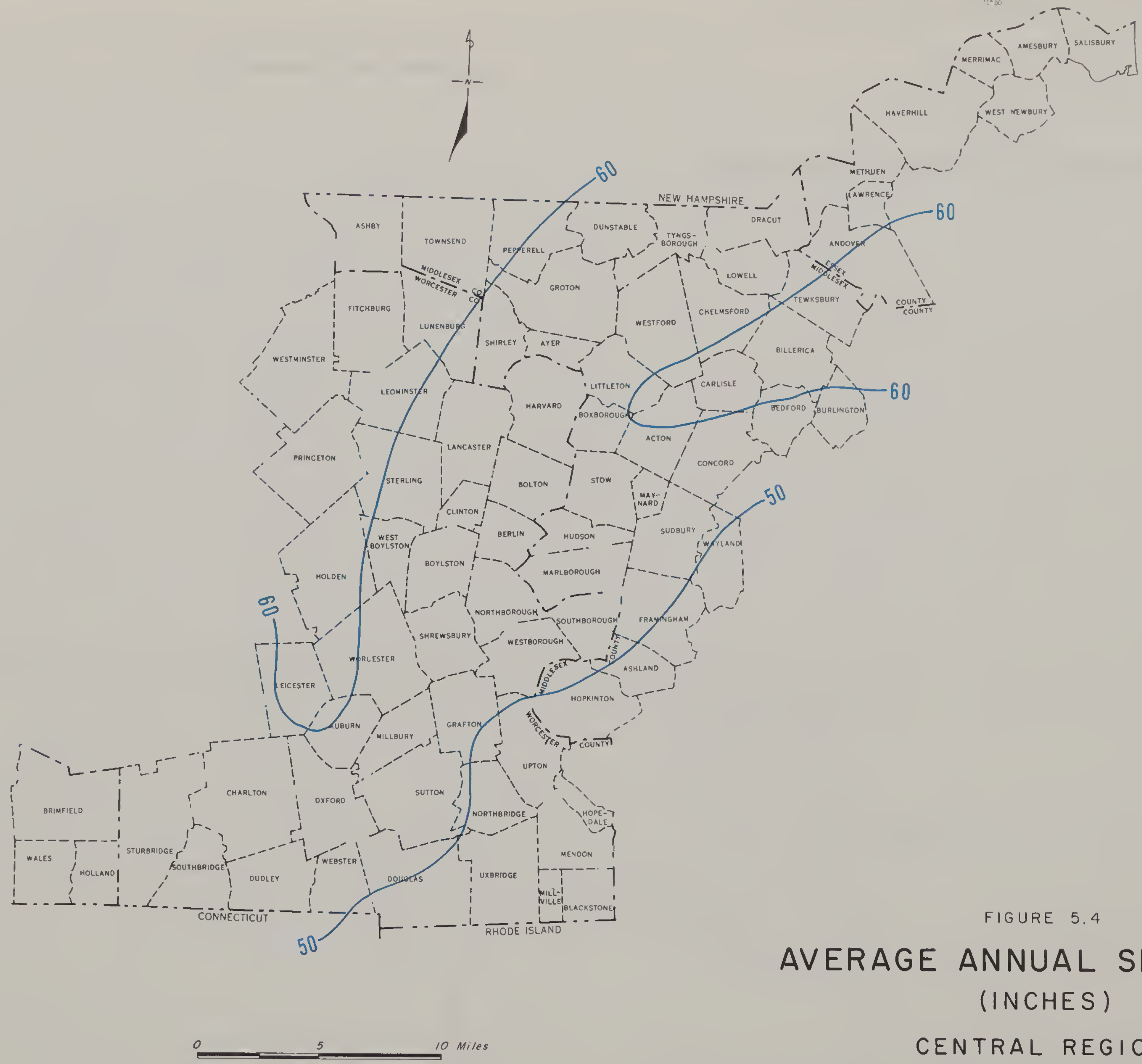

FIGURE 5.4

AVERAGE ANNUAL SNOWFALL

(INCHES)

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.1

STREAM GAGE DATA

USGS Stream Gage Number	Location	Drainage Area (sq mi)	Period of Record	Average Flow C.F.S.	Minimum Flow C.F.S.	Minimum Flow Date	Maximum Flow C.F.S.	Maximum Flow C.S.M.	Maximum Flow Date
01094400	Merrimac River Basin								
	No. Nashua River @ Fitchburg	63.6	Oct. 1972 - current	-	24	Aug. 6, 1974	2,080	32.7	Dec. 21, 1973
01095500	Merrimac River Basin								
	So. Branch Nashua @ Clinton	107.69	July 1896 - current	188	Flow diverted for MDC water supply				
01096000	Merrimac River Basin								
	Squannacook River @ W. Groton	62.8	Oct. 1949 - current	108	2	Sept. 7, 1965	4,010	63.9	Oct. 16, 1955
01096500	Merrimac River Basin								
	Nashua River @ E. Pepperell	433	Oct. 1935 - current	528	1.1	Aug. 13, 1939	20,900	48.3	Mar. 20, 1936
01096910	Merrimac River Basin								
	Boulder Brook @ E. Bolton	1.54	June 1971 - current	-	0.02	Aug. 25, 1971	71	46.1	Mar. 22, 1972
01097000	Merrimac River Basin								
	Assabet River @ Maynard	116	July 1941 - current	181	0.2	Feb. 7, 1965	4,250	36.6	Aug. 20, 1955
01097300	Merrimac River Basin		Occasional 1962-63						
	Nashoba Brook @ Acton	12.7	July 1963 - current	17.7	0.02	Sept. 6, 1968	360	28.3	Mar. 19, 1968
01097500	Merrimac River Basin								
	Sudbury River @ Framingham	75.2	Jan. 1875 - current	114	Flow diverted for MDC water supply				
01099500	Merrimac River Basin								
	Concord River @ Lowell	405	Oct. 1936 - current	457	4.0	Sept. 29, 1957	4,800	11.9	Mar. 22, 1968
01100000	Merrimac River Basin								
	Merrimac River @ Lowell	4635	June 1923 - current	7200	199	Sept. 23, 1923	173,000	37.3	Mar. 20, 1936
01100700	Merrimac River Basin								
	E. Meadow River @ Haverhill	4.93	Oct. 1962-Sept. 1974	9.01	0.05	Sept. 5, 1963	211	42.8	Mar. 19, 1968
01109500	Blackstone River Basin								
	Kettle Brook @ Worcester	31.3	Aug. 1923 - current	53.4	0.2	May 17, 1940	3,970	126.8	Aug. 19, 1955
01110000	Blackstone River Basin								
	Qunisigamond River @ N. Grafton	25.5	Oct. 1939 - current	41.4	0	Aug. 22, 1966	820	32.2	Aug. 20, 1955
01110500	Blackstone River Basin								
	Blackstone River @ Northbridge	139	Oct. 1939 - current	245	2	Aug. 29, 1941	16,900	121.6	Aug. 20, 1955
01111200	Blackstone River Basin								
	West River @ Uxbridge	27.9	Mar. 1962 - current	43.7	1.1	Sept. 12, 1963	370	13.3	Mar. 26, 1968
01123600	Thames River Basin								
	Quinebaug River @ Southbridge	99.1	Oct. 1962 - current	158	7.3	Nov. 21, 1964	1,270	12.8	Feb. 6, 1973
01124350	Thames River Basin								
	French River @ Hodges Village	31.0	Mar. 1962 - current	51.5	0	July 17, 1968	496	16.0	Mar. 20, 1962
01124750	Thames River Basin								
	Brown Brook @ Webster	0.49	Oct. 1962 - current	1.08	0	1963 - 1965	125	255.1	Mar. 18, 1968
01125000	Thames River Basin								
	French River @ Webster	85.3	Dec. 1948 - current	156	2	April 15, 1965	1,020	12.0	April 2, 1960

5.2 LAND USE

Land use in the Central Region is dominated by forest land which in 1971 comprised 61 percent of the region. Urban land, the next most dominant land use, comprised slightly more than 17 percent of the total acreage in the region. Agricultural uses comprised 9.4 percent of the area while water, wetlands, and other land uses make up the balance. Since 1971 the most significant change has been a decrease in agricultural uses and an increase in urban land.

5.2A Agricultural Land

In the 20-year period between 1951 and 1971, significant land use changes occurred. Regionally agricultural land decreased by slightly more than 100,000 acres or more than 50 percent of its agricultural base. In 1951, 18.9 percent of the region was in agricultural use, by 1971, only 9.4 percent was in such use. The SuAsCo Study Area lost the most, 33,853 acres or 59.7 percent of the 1951 agricultural land base. The Merrimack Study Area lost 25,795 acres or 54.4 percent, resulting in a 1971 agricultural land base of only 21,634 acres.

On the other hand, urban land use expanded from 77,804 acres in 1951 to 186,278 acres in 1971 (7.1 percent of the region in 1951, and 17.1 percent in 1971), an increase of 139 percent representing 108,474 acres.

Forest land acreage in the region decreased by 6,760 acres between 1951 and 1971. However, there were two substudy areas which experienced gains (Nashua - 6,060 acres; Thames - 2,981 acres). The remaining three substudy areas lost acreages ranging from 1,580 acres to 9,473 acres.

Table 5.2 summarizes the major changes in the various study areas.

TABLE 5.2 MAJOR LAND USE CHANGES, 1951-1971

Study Area	Agricultural Land (% Change)	Agricultural Land (Acres)	Urban Land (% Change)	Urban Land (Acres)	Forest Land (% Change)	Forest Land (Acres)
Merrimac	-54.4	-25,795	112.4	29,298	-8.8	-9,473
Nashua	-45.1	-22,698	140.3	18,481	3.1	6,060
Blackstone	-45.4	-12,789	88.8	15,603	-1.4	-1,580
SuAsCo	-59.7	-33,853	214.1	35,684	-3.3	-4,748
Thames	-34.1	-8,102	216.4	9,408	2.6	2,981
Central Region	-50.0	-103,237	139.4	108,474	-1.0	-6,760

Source: MacConnell et al.

Table 5.3 summarizes the land resource base in the region and the shares of each land use category to the total land base by each substudy area for the years 1951 and 1971. It is important to note that the other land category is composed of the following subcategories as presented in MacConnell's et al. data:[1/]

1. abandoned fields and abandoned orchards, most of which are reverting to forest or scrub brush;

2. gas, telephone, oil, or power line rights-of-way 100 feet or more maintained through wooded areas;

3. mining and waste disposal areas;

4. open or undeveloped land which is in the midst of or adjacent to urban areas; and

5. lands used for recreational purposes.

In 1971, there were 71,122 acres within the other land use category. The decrease in forest land would no doubt have been greater if it weren't for the fact that much land classified in the other category in 1951 entered the forest land category by 1971.

It should be noted that, when looking at the changes that have occurred, caution should be used. For example, increases in water acreage were due in part to the installation of water impoundments, but more accurate analysis of the 1971 aerial photos also explains some of the increase. Minimum size of plots categorized in 1951 was 10 acres; in 1971, the minimum size was decreased to 3 acres. Thus, certain rivers and streams that were categorized as something other than water in 1951 were categorized as water in 1971.

The wetland category also poses a problem. In 1952, beaver ponds, seasonally flooded flats and bogs were categorized as the dominant adjacent land use. In 1971, however, they were included within the wetland category. In both years of analysis, wooded swamps were included as forest land, since photo interpretation precluded doing otherwise. Thus, the wetland category should be considered as open wetlands. In summary, actual changes as listed in Table 5.3 should not be taken as gospel. In any case, the changes simply suggest the trends that have occurred in the land base for the 20-year period.

In terms of acreage changes, the most significant categories are agricultural land and urban land. As Table 5.2 shows, agricultural land decreased 103,237 acres, a drop of 50 percent. When it is considered that Massachusetts now imports approximately 85 percent of its food, a continuation of this trend is a rather disturbing thought. Much of the former

TABLE 5.3 LAND USE, 1951 AND 1971

	Cropland	Pasture	Agricultural Land 1 & 2	Forest	Wetland	Water	Industrial/ Commercial	Residential	Insti- tutional	Urban 6, 7, 8	Other	Total
	- - -	- - -	- - -	- - -	- - -	- - - Acres - - -	- - -	- - -	- - -	- - -	- - -	- - -
Merrimac												
1951	17,398	30,031	47,429	107,410	11,370	7,750	3,153	21,564	1,342	26,059	10,693	210,711
1971	13,036	8,598	21,634	97,937	8,804	8,739	10,977	41,405	2,975	55,357	18,240	210,711
Change in acres	-4,362	-21,433	-25,795	-9,473	-2,566	989	7,824	18,841	1,633	29,298	7,547	
1951 share (%)	8.3	14.3	22.5	51.0	5.4	3.7	1.5	10.2	0.6	12.4	5.1	
1971 share (%)	6.2	4.1	10.3	46.5	4.2	4.1	5.2	19.2	1.4	26.3	8.7	
Change in % share	-2.1	-10.2	-12.2	-4.5	-1.2	0.4	3.7	9.0	0.8	13.9	3.6	
Nashua												
1951	31,093	19,181	50,274	196,603	7,892	9,806	2,109	9,375	1,686	13,170	16,204	293,949
1971	16,893	10,683	27,576	202,663	4,382	11,804	3,966	24,822	2,863	31,651	15,873	293,949
Change in acres	-14,200	-8,498	-22,698	6,060	-3,510	1,998	1,857	15,447	1,177	18,481	-331	
1951 share (%)	10.6	6.5	17.1	66.9	2.7	3.3	0.7	3.2	0.6	4.5	5.5	
1971 share (%)	5.7	3.6	9.4	68.9	1.5	4.0	1.3	8.4	1.0	10.8	5.4	
Change in % share	-4.9	-2.9	-7.7	2.0	-1.2	0.7	0.6	5.2	0.4	6.3	-0.1	
Blackstone												
1951	12,452	15,743	28,195	109,600	4,294	4,906	2,500	13,755	1,307	17,562	11,658	176,215
1971	9,867	5,539	15,406	108,020	3,583	5,002	5,452	25,492	2,221	33,165	11,039	176,215
Change in acres	-2,585	-10,204	-12,789	-1,580	-711	96	2,952	11,737	914	15,603	-619	
1951 share (%)	7.1	8.9	16.0	62.2	2.4	2.8	1.4	7.8	0.7	10.0	6.6	
1971 share (%)	5.6	3.1	8.7	61.3	2.0	2.8	3.1	14.5	1.3	18.8	6.3	
Change in % share	-1.5	-5.8	-7.3	-0.9	-0.4	0.0	1.7	6.7	0.6	8.8	-0.3	
SuAsCo												
1951	29,655	27,025	56,680	143,494	12,001	6,364	1,686	13,756	1,042	16,666	12,862	248,067
1971	14,365	8,462	22,827	138,746	9,134	7,478	9,450	40,243	2,657	52,350	17,532	248,067
Changes in acres	-15,290	-18,563	-33,853	-4,748	-2,867	1,114	7,582	26,487	1,615	35,684	4,670	
1951 share (%)	12.0	10.9	22.8	57.8	4.8	2.6	0.8	5.5	0.4	6.7	5.2	
1971 share (%)	5.8	3.4	9.2	55.9	3.7	3.0	3.8	16.2	1.1	21.1	7.1	
Change in % share	-6.2	-7.5	-13.6	-1.9	-1.1	0.4	3.0	10.7	0.7	14.4	1.9	
Thames												
1951	5,517	18,216	23,733	114,158	4,324	5,246	469	3,680	198	4,347	11,306	163,114
1971	9,514	6,117	15,631	117,139	2,218	5,933	2,406	10,579	770	13,755	8,438	163,114
Change in acres	3,997	-12,099	-8,102	2,981	-2,106	687	1,937	6,899	572	9,408	-2,868	
1951 share (%)	3.4	11.2	14.5	70.0	2.7	3.2	0.3	2.3	0.1	2.7	6.9	
1971 share (%)	5.8	3.8	9.6	71.8	1.4	3.6	1.5	6.5	0.5	8.4	5.2	
Change in % share	2.4	-7.4	-4.9	1.8	-1.3	0.4	1.2	4.2	0.4	5.7	-1.7	
Total												
1951	96,115	110,196	206,311	671,265	39,881	34,072	10,099	62,130	5,575	77,804	62,723	1,092,056
1971	63,675	39,399	103,074	664,505	28,121	38,956	32,251	142,541	11,486	186,278	71,122	1,092,056
Change in acres	-32,440	-70,797	-103,237	-6,760	-11,760	4,884	22,152	80,411	5,911	108,474	8,399	
1951 share (%)	8.8	10.1	18.9	61.5	3.7	3.1	0.9	5.7	0.5	7.1	5.7	
1971 share (%)	5.8	3.6	9.4	60.8	2.6	3.6	3.0	13.1	1.1	17.1	6.5	
Change in % share	-3.0	-6.8	-9.5	-.7	-1.1	0.5	2.1	7.4	0.6	10.0	0.8	

agricultural acreage has gone into urban uses. From an agricultural perspective, although the actual conversion acreage may not be that large, there are a number of important ramifications.

From an economic viewpoint, statewide agricultural earnings, while amounting to over $200 million, are quite insignificant relative to the total earnings in the state. Agricultural pursuits employ less than 1 percent of the labor force and contribute comparably to total personal income. It should be noted, however, when agricultural enterprises are considered within the goals and objectives of local or regional planning groups, the simple economic viewpoint is inadequate.

If we look at Table 5.3, the two study areas which experienced the greatest losses in agricultural land were the SuAsCo and the Merrimack. These losses are a direct result of population shifts from the near-in Boston residential area to those further out. The Blackstone study area experienced a similar decline primarily due to the influences of the Worcester Metropolitan area.

There are a number of factors which appear to aggravate the continuing decrease in agricultural land:

1. Zoning ordinances--most towns in the region have zoned agricultural land to permit residential use on lots of 1 acre or less, and in some cases, industrial and commercial use is also allowed. Most zoning regulations incorporate an implicit assumption that farming is a residual or temporary use which will be replaced by nonagricultural uses, and zoning often times is in direct opposition to the publicly professed land use objective of preserving agricultural land.

   Section 81 of Chapter 41, General Laws, stipulates that for any development which will be placed upon frontage along already existing public roads, subdivision review is not required. Although recently introduced legislation has a requirement that any development on more than two lots would require subdivision approval, the fact that there is no minimum time frame incorporated into the act somewhat diminishes its potential impact.[2/] The result is a large degree of strip development which creates the most expensive pattern for public services. Such development patterns also maximize the potential encroachment on agricultural land. For example, as development continues, farmer field operations taking place behind the strip may be subject to nuisance ordinances forced on the operator by the new residents who wield more political power. The indirect and direct impacts of zoning regulations seem to be diametrically opposed to the professed intent of preserving agriculture.

2. Relative to competing agricultural areas, especially those in truck farm type crops, Massachusetts' climate provides a relatively short growing season. This factor together with the distribution of soil groups, size of holdings, and labor costs, produces a comparative disadvantage. As Christensen pointed out, nearly three million acres were cleared and used for agriculture in 1860. Today most of this land is now growing trees. But even if this former cropland was brought back into production, the resulting food costs would be higher than they now are because of the expense of working the land and the relatively low yields:

> "Plowing and tilling an acre of stony land has a much higher cost than plowing an acre of nonstony land and, when this extra cost is combined with lower yields, the resulting food produce has a high production cost per unit of yield."[3/]

3. A third factor that helps explain the loss of agricultural land is the fact that there are very few storage facilities in the state; thus, the advantages of bulk shipping from the food and feed crop exporting areas cannot be gained. As a result, the unit cost of transporting the necessary productive inputs are high and, consequently, the cost of raising livestock and crops are higher than in those areas which have adequate storage facilities.

   For example, in 1945, poultry production was the most important source of farm income in Massachusetts (38.1 percent) [4/] as compared to 1974 when it amounted to approximately 13 percent of all agricultural income.[5/] This decline was brought about by the vast expansion of poultry enterprises in the DelMarVa Peninsula and areas south. The climatic difference is such that corn and soybeans, the major feed ingredients, grow prolifically in these southern areas. And when there are inadequacies in cropland area, the presence of large storage facilities permit bulk transportation of feed at minimal costs. As a result, the poultry areas of the south can produce chickens at a lower cost, while equalling or exceeding the quality of the Massachusetts products.

4. A fourth reason which explains the loss of agricultural land is two-fold: higher transportation rates and a lack of a coordinated marketing system. As Platt, et al. diagrammed, Franklin and Hampshire Counties are the major agricultural areas in the state.[6/] Most of this area which borders the Connecticut River is in vegetable crop production. But the

lack of consistent product quality tied with a sporadic supply schedule has precluded the development of vegetable processing industry or a well coordinated fresh-market system. As a result, other regions in the country, namely Florida and California with their longer growing seasons, crop varieties, and modern processing plants, supply a great deal of the fresh and processed vegetable products to Massachusetts.

In 1973, the Massachusetts General Court enacted Chapter 61A as a step in curbing the loss of agricultural land. This act provided for the assessment of agricultural land at a value based upon its agricultural or horticultural uses. Although a rigorous assessment of the impact of this act has not been undertaken, the general consensus is that it has been of minimal effectiveness in curbing the loss of agricultural land. The primary explanation for this result is that there was defacto agricultural assessment prior to the passage of the act. As Barlowe and Alter stated:[7/]

> "How far use-value assessment programs can go in protecting agricultural and open space land depends largely on the emphasis given to the current use-protection objective.
>
> "Landowners have a natural economic incentive for favoring taxing arrangements that provide them with benefits and still leave them with the option of developing or selling their lands. A protection policy, in contrast, calls for tight declassification procedures that discourage or prevent withdrawals once lands have been accepted for (agricultural assessment) classification.
>
> "These two objectives are in conflict. Programs that emphasize the first objective provide little protection for existing land uses while those that emphasize the protection goal offer little incentive for owner participation. Considerable emphasis has been given to protectionist goals in several laws enacted in the past decade, but even the most restrictive of these involves elements of compromise between the two objectives.
>
> "Recognition of these factors prompts the conclusion that, by itself, use-value assessment cannot provide more than a partial answer to the farmland and open space preservation problem. Its chief merit lies in the role it can play in buying time, particularly in semirural areas, for state and local governments to seek and enact supplemental programs to protect agricultural and open space lands."

Defacto agricultural assessment has precluded the agricultural assessment act from being an effective means, of preserving agricultural and horticultural lands. However, the situation has recently changed since each city and town must now assess property values at 100 percent of market value. Such an assessment would preclude defacto assessments and, therefore, the potential effectiveness of the agricultural assessment act may increase substantially.

To further the potential of agricultural preservation, the General Court enacted a development rights bill which authorizes cities and towns to purchase the development rights to agricultural land. Recently, another bill was signed into law providing for state acquisition of farmland development rights as "agricultural preservation restrictions" with an initial $5 million funding for a pilot program. This restriction program can be used in conjunction with town based efforts under the first named legislation.

The effectiveness of a development rights program may also be limited, because land is merely one of many productive inputs. In a recent investigation trying to explain the loss of agricultural land, the variables having to do with increased population growth, increasing taxes, and increased urbanization were insignificant in explaining the loss. This strongly suggests that the agricultural demise results from low net income to the agricultural community. To the extent that the development rights program supplies additional capital to the farmers and, to the extent that such capital is invested in cost reducing measures, then the development rights program may have a positive impact.

5.2B Agricultural Land Study

The U.S. Department of Agriculture is concerned about any action that tends to impair the productive capacity of American agriculture. The continuing loss of farmland in the Central Region is such an action. Nationwide, the SCS has an Inventory and Monitoring Program to inventory and keep current, prime and unique farmland acreage. Farmlands that are of statewide or local importance for producing crops are also identified. The nation needs to know the extent and location of the best land for producing food, feed, fiber, and forage.

The first phase of the farmland inventory will be conducted in those counties which have published soil surveys available. In the Central Region, no soil surveys have been completed, however, northern Essex County is pending publication. Results of the nationwide Land Inventory and Monitoring Program is not expected in the Central Region until the early 1980s.

Three categories of farmland are being inventoried:

1. Prime Farmland--Prime farmland is land best suited for producing food, feed, forage, and fiber. In addition the land could be used for cropland, pastureland, rangeland, forest land, or other land, but not urban, builtup land, or water. It has the quality, growing season, and moisture supply needed to produce sustained high yields of crops economically, when treated and managed (including water management) according to modern farming methods.

2. Unique farmland--Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods. Examples of such crops in Massachusetts are cranberries and fruit orchards.

   Unique farmland has the following characteristics:

   a. It is used for a specific high-value food or fiber crop.

   b. It has a moisture supply that is adequate for the specific crop; the supply is from stored moisture, precipitation, or a developed irrigation system.

   c. It combines favorable factors of soil quality, growing season, temperature, humidity, air drainage, elevation, aspect, or other conditions, such as, nearness to market, that favor the growth of a specific food or fiber crop.

3. Additional Farmland of Statewide and Local Importance--This is land, in addition to prime and unique farmlands, that is of statewide and local importance for the production of food, feed, fiber, and forage crops. Criteria for defining and delineating this land are to be determined by state and local personnel familiar with the specific needs of the region. These lands include some of those commonly utilized for pasture and hay.

To illustrate the dramatic irreversible loss of farmland to urbanization in the Central Region, the Massachusetts Water Resources Study has analyzed data for 21 towns. Basic data was prepared in a manner which can make it useful to a variety of state and local agencies in efforts to protect existing farmland.

Towns were selected to represent a geographic distribution in the region. A prerequisite for inclusion of a town was the availability of a published soil survey for the community. Communities selected are shown on Figure 5.5.

A base map for the community was prepared at scale 1:24,000 (1 inch = 2,000 feet), using the U.S. Geological Survey topographic maps. Detailed soils data was adjusted to the base map and a transparent mylar overlay of the detailed soils map prepared. Another mylar overlay was constructed which indicated all prime farmland and farmland of state and local importance.

Using a transparent copy of this farmland soils overlay, land use data was added, using the 1971 Massachusetts Map Down maps. Existing farming was mapped wherever it occurred in the town. In addition, land uses were mapped for all areas of farmland soil.

The data contained in this combined farmland soils-land use overlay was measured and summarized. Results are presented in Tables 5.4 to 5.8. Some interesting conclusions can be drawn from this study of farmland in the region.

First, land being farmed represents a very small percentage of the total town area. It ranges from 20.7 percent of the area of West Newbury to only 4.4 percent of the town of Douglas.

Towns sampled were selected because they had more prime farmland soil, but even in these towns prime farmland soils on the average constitute less than 14 percent of the town area.

Approximately one-fourth of the prime farmland has been lost through urbanization. The remaining is divided rather equally between forest land and farmland.

For soils of state and local importance, many of the same conclusions are evident: (a) these soils constitute about 30 percent of the town area; (b) a small percentage of land is being farmed with a great percentage used for urban land; (c) forest land is the dominant land use.

John Foster of the Department of Food and Resource Economics, University of Massachusetts, undertook a study similar to that which has been described above.[8/] In Foster's study, a sample of 26 towns was examined to determine the changes that occurred on agricultural land between 1951 and 1971. His findings are very similar to those enumerated above: 42 percent of the better agriculture soils are in forest land because of previous reversion, and urban land is found on 12 percent of these soils. His sample of 26 towns differed somewhat in that he chose only those towns with large agricultural areas relative to urban areas. As a result, his findings showed that in 1971, intensive agriculture (tilled land, orchard and nursery uses) was found on 25 percent or 119,000 acres of the better agricultural soils in the state.

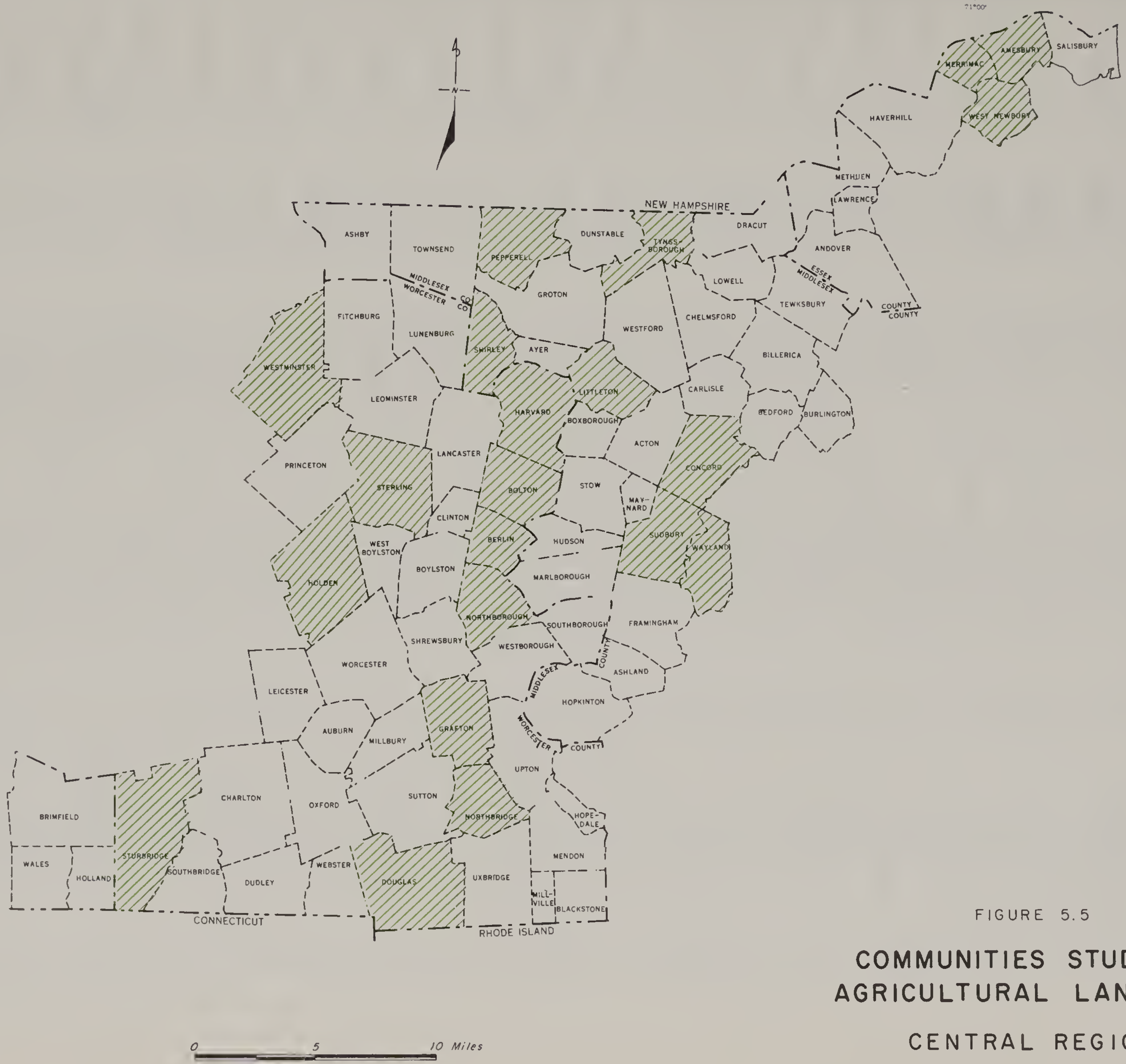

FIGURE 5.5

COMMUNITIES STUDIED IN AGRICULTURAL LAND STUDY

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.4 EXISTING FARMLAND

Community	Cropland	Pasture	Orchard	Total
	Acres (Percent of Town Area)			
Amesbury	857 (9.7)	526 (5.9)	19 (0.2)	1,402 (15.8)
Berlin	304 (3.6)	824 (9.8)	100 (1.2)	1,228 (14.6)
Bolton	793 (6.2)	657 (5.1)	513 (4.0)	1,963 (15.4)
Concord	1,692 (10.2)	687 (4.2)	2 *	2,381 (14.4)
Douglas	728 (3.0)	330 (1.3)	11 *	1,069 (4.4)
Grafton	1,797 (12.3)	597 (4.1)	39 (0.3)	2,433 (16.6)
Harvard	963 (5.6)	308 (1.8)	693 (4.0)	1,964 (11.4)
Holden	569 (2.5)	569 (2.5)	4 *	1,142 (4.9)
Littleton	1,059 (9.3)	724 (6.4)	189 (1.7)	1,972 (17.4)
Merrrimac	570 (10.0)	191 (3.4)	29 (0.5)	790 (13.9)
Northborough	353 (3.0)	789 (6.7)	227 (1.9)	1,369 (11.6)
Northhbridge	685 (5.9)	177 (1.5)	3 *	865 (7.4)
Pepperell	1,473 (10.0)	1,149 (7.8)	114 (0.8)	2,736 (18.6)
Shirley	370 (3.8)	460 (4.8)	57 (0.6)	887 (9.2)
Sterling	2,541 (12.6)	756 (3.7)	671 (3.3)	3,968 (19.7)
Sturbridge	661 (2.6)	416 (1.7)	58 (0.2)	1,135 (4.5)
Sudbury	1,400 (8.9)	356 (2.3)	5 *	1,761 (11.2)
Tyngsborough	463 (4.1)	209 (1.9)	19 (0.2)	691 (6.2)
Wayland	582 (5.7)	434 (4.3)	0 *	1,016 (10.0)
Westminster	345 (1.4)	953 (4.0)	11 *	1,309 (5.5)
West Newbury	853 (9.0)	861 (9.1)	257 (2.7)	1,971 (20.7)

* Less than 0.1 percent.

TABLE 5.5 PRIME FARMLAND SOILS

Community	Cropland	Pasture	Orchard	Forest	Available	Urban	Total*
	Land Use						
	Acres (Percent of Prime Soils in this Land Use)						
Amesbury	388 (18.9)	209 (10.2)	17 (0.8)	553 (26.9)	119 (5.8)	766 (37.3)	2,052 (23.1)
Berlin	200 (16.8)	271 (22.8)	30 (2.5)	293 (24.6)	145 (12.2)	250 (21.0)	1,189 (14.1)
Bolton	406 (19.2)	211 (10.0)	287 (13.6)	752 (35.6)	161 (7.6)	293 (13.9)	2,110 (16.5)
Concord	391 (32.8)	79 (6.6)	0	413 (34.6)	78 (6.5)	231 (19.4)	1,192 (7.2)
Douglas	270 (18.7)	69 (4.8)	1 (0.1)	638 (44.1)	103 (7.1)	364 (25.2)	1,445 (5.9)
Grafton	790 (32.5)	126 (5.2)	15 (0.6)	557 (22.9)	310 (12.7)	634 (26.1)	2,432 (16.6)
Harvard	390 (20.8)	71 (3.8)	271 (14.4)	772 (41.1)	140 (7.5)	233 (12.4)	1,877 (10.9)
Holden	239 (9.5)	170 (6.8)	3 (0.1)	1,505 (60.1)	62 (2.5)	526 (21.0)	2,505 (10.9)
Littleton	409 (32.2)	165 (13.0)	91 (7.2)	219 (17.2)	111 (8.7)	274 (21.6)	1,269 (11.2)
Merrimac	251 (23.8)	83 (7.9)	9 (0.8)	416 (39.5)	65 (6.2)	228 (21.7)	1,052 (18.5)
Northborough	247 (9.1)	333 (12.3)	115 (4.2)	660 (24.3)	235 (8.7)	1,123 (41.4)	2,713 (22.9)
Northbridge	290 (24.6)	42 (3.6)	0	383 (32.6)	112 (9.5)	349 (29.7)	1,176 (10.0)
Pepperell	659 (32.3)	360 (17.6)	63 (3.1)	604 (29.6)	77 (3.8)	278 (13.6)	2,041 (13.8)
Shirley	130 (14.8)	64 (7.3)	6 (0.7)	443 (50.4)	80 (9.1)	156 (17.7)	879 (9.1)
Sterling	1,041 (34.1)	137 (4.5)	213 (7.0)	1,136 (37.2)	228 (7.5)	298 (9.8)	3,053 (15.1)
Sturbridge	222 (12.8)	57 (3.3)	11 (0.6)	879 (50.5)	192 (11.0)	379 (21.8)	1,740 (6.9)
Sudbury	597 (28.0)	109 (5.1)	0	875 (41.0)	178 (8.3)	373 (17.5)	2,132 (13.6)
Tyngsborough	202 (27.4)	16 (2.2)	3 (0.4)	298 (40.4)	25 (3.4)	194 (26.3)	738 (6.6)
Wayland	196 (14.0)	96 (6.9)	0	491 (35.0)	79 (5.6)	539 (38.5)	1,401 (13.8)
Westminster	101 (11.1)	172 (18.9)	0	362 (39.8)	45 (4.9)	230 (25.3)	910 (3.8)
West Newbury	537 (20.6)	354 (13.6)	121 (4.6)	1,017 (39.0)	184 (7.0)	396 (15.2)	2,609 (27.4)

* Percent of the town in Prime Farmland Soil.

TABLE 5.6 SOILS OF STATE AND LOCAL IMPORTANCE FOR FARMING

Community	Cropland	Pasture	Orchard	Land Use Forest	Available	Urban	Total
	Acres (Percent of State and Local Important Soils in this Use)						
Amesbury	191 (8.6)	112 (5.0)	2 *	1,205 (54.1)	76 (3.4)	640 (28.8)	2,226 (25.1)
Berlin	71 (4.4)	313 (19.5)	31 (1.9)	927 (57.7)	94 (5.8)	171 (10.6)	1,607 (19.1)
Bolton	116 (4.0)	187 (6.4)	96 (3.3)	1,928 (66.2)	212 (7.3)	373 (12.8)	2,912 (22.8)
Concord	797 (11.3)	329 (4.7)	2 *	3,377 (47.9)	430 (6.1)	2,114 (30.0)	7,049 (42.6)
Douglas	304 (10.2)	149 (5.0)	5 (0.2)	2,179 (73.1)	111 (3.7)	233 (7.8)	2,981 (12.2)
Grafton	622 (13.9)	339 (7.6)	11 (0.2)	1,940 (43.4)	425 (9.5)	1,131 (25.3)	4,468 (30.5)
Harvard	204 (8.0)	75 (2.9)	114 (4.4)	1,641 (64.0)	88 (3.4)	441 (17.2)	2,563 (14.9)
Holden	196 (3.9)	194 (3.8)	1 *	3,292 (65.2)	133 (2.6)	1,234 (24.4)	5,050 (21.9)
Littleton	434 (14.3)	272 (9.0)	65 (2.1)	1,267 (41.8)	249 (8.2)	743 (24.5)	3,030 (26.7)
Merrimac	189 (9.8)	48 (2.5)	11 (0.6)	1,333 (69.1)	92 (4.8)	256 (13.3)	1,929 (34.0)
Northborough	69 (2.8)	184 (7.4)	29 (1.2)	1,272 (50.8)	166 (6.6)	781 (31.2)	2,501 (21.2)
Northbridge	157 (5.8)	64 (2.3)	0	1,673 (61.3)	150 (5.5)	683 (25.0)	2,727 (23.3)
Pepperell	459 (9.7)	364 (7.7)	25 (0.5)	3,170 (66.8)	185 (3.9)	541 (11.4)	4,744 (32.2)
Shirley	148 (4.0)	225 (6.1)	22 (0.6)	2,546 (68.7)	207 (5.6)	557 (15.0)	3,705 (38.5)
Sterling	911 (14.6)	269 (4.3)	337 (5.4)	3,598 (57.8)	401 (6.4)	707 (11.4)	6,223 (30.8)
Sturbridge	199 (7.6)	111 (4.2)	30 (1.1)	1,590 (60.8)	266 (10.2)	417 (16.0)	2,613 (10.4)
Sudbury	608 (9.0)	166 (2.5)	5 (0.1)	3,288 (48.9)	476 (7.1)	2,180 (32.4)	6,723 (42.9)
Tyngsborough	177 (5.1)	98 (2.8)	11 (0.3)	2,167 (62.1)	181 (5.2)	857 (24.5)	3,491 (31.1)
Wayland	314 (9.8)	232 (7.3)	0	1,128 (35.4)	202 (6.3)	1,314 (41.2)	3,190 (31.4)
Westminster	132 (3.6)	443 (12.1)	0	2,376 (65.1)	224 (6.1)	476 (13.0)	3,651 (15.3)
West Newbury	109 (7.0)	220 (14.1)	69 (4.4)	923 (59.1)	126 (8.1)	115 (7.4)	1,562 (16.4)

* Less than 0.1 percent.

TABLE 5.7 PRIME FARMLAND SOILS AND SOILS OF STATE AND LOCAL IMPORTANCE FOR FARMING

Community	Land Use: Cropland	Pasture	Orchard	Forest	Available	Urban	Total
	Acres (Percent of Prime Farmland Soils and Soils of State and Local Importance in this Land Use)						
Amesbury	579 (13.5)	321 (7.5)	19 (0.4)	1,758 (41.1)	195 (4.6)	1,406 (32.9)	4,278
Berlin	271 (9.7)	584 (20.9)	61 (2.2)	1,220 (43.6)	239 (8.5)	421 (15.1)	2,796
Bolton	522 (10.4)	398 (7.9)	383 (7.6)	2,680 (53.4)	373 (7.4)	666 (13.3)	5,022
Concord	1,188 (14.4)	408 (5.0)	2 *	3,790 (46.0)	508 (6.2)	2,345 (28.5)	8,241
Douglas	574 (13.0)	218 (4.9)	6 (0.1)	2,817 (63.6)	214 (4.8)	597 (13.5)	4,426
Grafton	1,412 (20.5)	465 (6.7)	26 (0.4)	2,497 (36.2)	735 (10.6)	1,765 (25.6)	6,900
Harvard	594 (13.4)	146 (3.3)	385 (8.7)	2,413 (54.3)	228 (5.1)	674 (15.2)	4,440
Holden	435 (5.8)	364 (4.8)	4 (0.1)	4,797 (63.5)	195 (2.6)	1,760 (23.3)	7,555
Littleton	843 (19.6)	437 (10.2)	156 (3.6)	1,486 (34.6)	360 (8.4)	1,017 (23.7)	4,299
Merrimac	440 (14.8)	131 (4.4)	20 (0.7)	1,749 (58.7)	157 (5.3)	484 (16.2)	2,981
Northborough	316 (6.1)	517 (9.9)	144 (2.8)	1,932 (37.1)	401 (7.7)	1,904 (36.5)	5,214
Northbridge	447 (11.5)	106 (2.7)	0	2,056 (52.7)	262 (6.7)	1,032 (26.4)	3,903
Pepperell	1,118 (16.5)	724 (10.7)	88 (1.3)	3,774 (55.6)	262 (3.9)	819 (12.1)	6,785
Shirley	278 (6.1)	289 (6.3)	28 (0.6)	2,989 (65.2)	287 (6.3)	713 (15.6)	4,584
Sterling	1,952 (21.0)	406 (4.4)	550 (5.9)	4,734 (51.0)	629 (6.8)	1,005 (10.8)	9,276
Sturbridge	421 (9.7)	168 (3.9)	41 (0.9)	2,469 (56.7)	458 (10.5)	796 (18.3)	4,353
Sudbury	1,205 (13.6)	275 (3.1)	5 *	4,163 (47.0)	654 (7.4)	2,553 (28.8)	8,855
Tyngsborough	379 (9.0)	114 (2.7)	14 (0.3)	2,465 (58.3)	206 (4.9)	1,051 (24.8)	4,229
Wayland	510 (11.1)	328 (7.1)	0	1,619 (35.3)	281 (6.1)	1,853 (40.4)	4,591
Westminster	233 (5.1)	615 (13.5)	0	2,738 (60.0)	269 (5.9)	706 (15.5)	4,561
West Newbury	646 (15.5)	574 (13.8)	190 (4.6)	1,940 (46.5)	310 (7.4)	511 (12.2)	4,171

* Less than 0.1 percent.

TABLE 5.8 "OTHER" 1/ SOILS BEING FARMED

Community	Cropland	Pasture	Orchard	Total & % of Town Area	% Existing Farmland on Other Soils
		Acres			
Amesbury	278	205	0	483 (5.4)	34.4
Berlin	33	240	39	312 (3.7)	25.4
Bolton	271	259	130	660 (5.2)	33.6
Concord	504	279	0	783 (4.7)	32.9
Douglas	154	112	5	271 (1.1)	25.3
Grafton	385	132	13	530 (3.6)	21.8
Harvard	368	162	308	838 (4.9)	42.7
Holden	134	205	0	339 (1.5)	29.7
Littleton	216	287	33	536 (4.7)	27.2
Merrimac	130	60	9	199 (3.5)	25.2
Northborough	37	270	83	390 (3.3)	28.5
Northbridge	238	71	3	312 (2.7)	36.1
Pepperell	355	425	26	806 (5.5)	29.5
Shirley	92	171	29	292 (3.0)	32.9
Sterling	589	350	121	1,060 (5.2)	26.7
Sturbridge	240	248	17	505 (2.0)	44.5
Sudbury	195	80	0	275 (1.8)	15.6
Tyngsborough	84	95	5	184 (1.6)	26.6
Wayland	71	106	0	177 (1.7)	17.4
Westminster	112	338	11	461 (1.9)	35.2
West Newbury	107	287	67	561 (5.9)	28.5

1/ "Other" soils are all soils except those classified as prime farmland soils or soils of state and local importance for farming.

Foster also developed a data base to show how agricultural land uses changed in the state between 1951 and 1971. He divided the acres of land tilled in 1971 into three soil productivity groups: "best," "good," and "poor." Approximately half of the state's tilled land was found on soils classified as "best" for agriculture, and another third was found on moderately good soils. Between 1951 and 1971, 5,900 acres per year were lost from tilled agricultural land to nonagricultural uses. Of this amount, 1,700 acres were classified as "best" agricultural land and went into the following uses: 400 acres became abandoned, 900 acres moved into urban uses, 200 acres became forested, and another 200 acres went into other uses (primarily recreation, but also includes mining, waste disposal, and wetlands). Another 1,500 acres were classified as "moderately" good agricultural soil and went into the following uses: 400 acres became abandoned, 700 acres went to urban uses, 200 acres went to forest uses, and another 200 acres went to other uses. A total of 56,000 acres went from tilled agricultural land of all types to urban uses between 1951 and 1971, and 32,000 acres of that amount were "best" and "moderate" agricultural land. In summary, almost half of the agricultural land that went into nonagricultural uses was relatively good productive agricultural land. It must also be recognized that there were 84,000 acres of best and moderate agricultural land that were abandoned between 1951 and 1971. This acreage, unless committed to another use, will also revert to forest land.

Maps and data were developed for each of the towns studied through a cooperative agreement between the Soil Conservation Service, United States Department of Agriculture, and the Massachusetts Agricultural Experiment Station University of Massachusetts. Soils information was taken from field surveys of the Soil Conservation Service and all maps corrected to USGS quad sheet base. Copies of this data are expected to be made available to those towns studied in a packet form. Plans for sampling additional towns for other studies are proposed. To assist communities in assessing the status of their agricultural resource base, the Soil Conservation Service can provide a limited number of transparent overlays of the data compiled for this agricultural land study. The map data can be helpful in visualizing the extent of agricultural soils, existing agricultural enterprise, and in predicting future agricultural impacts of urban growth. The maps should be useful to planning boards, zoning boards of appeal, and conservation commissions. They are especially useful to communities about to embark on measures designed to protect their agricultural resources.

To illustrate the types of data available and the scope of information contained therein, a map has been prepared for the town of Sterling and printed as Figure 5.6 of this report. This map is the combination of three overlays and is intended to publicize the data available in the 21 communities sampled. Several other combinations or permutations of the basic overlays are possible depending on the needs of the community. Interested town officials should direct their requests to the local Conservation District.

MASS. DEPT. OF ENVIRONMENTAL MGT. PHOTO

FIGURE 5.6

AGRICULTURAL LAND MAPPING EXAMPLE

TOWN OF STERLING
WORCESTER COUNTY, MASSACHUSETTS

1 0 1 Mile

SEPTEMBER 1976

LEGEND:

FARM LAND SOILS

- PRIME FARM LAND
- LAND OF STATE AND LOCAL IMPORTANCE FOR FARMING

LAND USE ON FARM LAND SOILS & EXISTING FARM LAND

- AGRICULTURAL LAND
- P PASTURE
- C CROPLAND
- O ORCHARD
- FOREST LAND
- URBAN LAND (UNAVAILABLE)
- A AVAILABLE LAND

BASE SOURCE: U.S.G.S. Topo Quad Sheets 1:24,000

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

USDA SCS HYATTSVILLE MD 1978

5.2C Forest Land

Forest land provides economic, environmental and social benefits. These benefits are in the form of wood products, water, wildlife, forage and recreation. The types and amounts of benefits produced from forest land are determined by the owners, subject to factors such as location, land productivity, and land conditions of site and soil. The owners can, for example, use their land for wood products, recreation and forage, and within limitations determine the mix of these benefits. They can also manage their properties to enhance water and wildlife benefits, even though these benefits transcend ownership boundaries.

Data on forest land ownership, number of acres owned, and reasons for ownership can be useful in drawing conclusions on the forest land resource base, and its potential outputs and benefits.

In the region, 664,505 acres are classed as forest land. Approximately 89 percent of this is in private ownership, which includes individuals, partnerships and corporations. Privately owned lands are usually not open to the general public. Eleven percent of the forest land is in public ownership, which includes state, local and federal governments. Publicly owned lands are usually open for public use, with stated exceptions.

The commercial forest land in the Central Region is owned in various sized tracts. An estimated 65 percent of the owners own 9 or fewer acres (see Table 5.9). A study by Kingsley[9/] of commercial forest landowners in Massachusetts shows that 4 percent of the owners control 10 percent of the commercial forest land for timber production. Fifty-seven percent of the owners control 45 percent of the land for investments or as part of their residences. The remaining 39 percent of commercial forest land is used in many diverse ways. Forest land ownership is shown in Table 5.10.

Kingsley estimated that 56 percent of the privately owned commercial forest land in southern New England (Massachusetts, Connecticut and Rhode Island) is available for the cutting of wood products. Using this percentage on the 664,505 acres of available forest land in the Central Region indicates that 372,000 acres are available for the cutting of wood products.

TABLE 5.9 OWNERSHIP OF COMMERCIAL FOREST LAND BY SIZE CLASS, NUMBER OF OWNERS, AND ACRES OWNED 1/

SIZE CLASS (acres)	OWNERS (percent)	ACRES OWNED (percent)
1-9	65	7
10-19	10	6
20-49	11	17
50-99	8	24
100-199	5	27
200-499	1	9
500+	neg.	10

1/ Derived from unpublished data on forest land ownership in Massachusetts, Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

TABLE 5.10 REASONS FOR OWNING FOREST LAND BY NUMBER OF OWNERS AND ACREAGE OWNED, MASSACHUSETTS

REASON	OWNERS (percent)	ACREAGE OWNED (percent)
Land investment	16	19
Recreation	16	21
Timber Production	4	10
General farm use	9	12
Part of residence	41	26
Other	14	12
Total	100	100

Source: Kingsley, op. cit.

5.3 FLOODING

In the area of flooding, the Massachusetts Water Resources Study has focused on inland flooding only. Although damage from tidal flooding occurs in the northeastern part of the region, there are no viable options available through USDA programs to reduce the damage. In fact, there are few alternatives to reduce tidal damage except the relocation of flood prone development. The National Flood Insurance Program, with its restriction on development of flood prone areas, will tend to limit future increases in coastal flood damage, but the existing damageable property will remain in peril.

The Massachusetts Coastal Zone Management Program has established a set of 38 policies for the coastal zone which includes five coastal hazard policies. These five are:

Policy (8) Discourage further growth and development in hazardous areas and preserve natural buffers throughout the coastal zone.

a. Restrict new development in identified V and E zones and in barrier beach, sandy beach, primary dune, and salt marsh Significant Resource Areas to the permitted uses defined under Policy 1, Marine Environment section.

b. Condition new development in contiguous upland areas within a zone extending landward to 100 feet inland of the limit of the 100-year flood, especially within designated areas for Preservation or Restoration to ensure that existing hazards are not exacerbated and that the proposed uses or activities are appropriate in light of the risks of damage.

c. Ensure that development proposed to be located in inter-tidal areas or offshore in coastal water bodies will not exacerbate existing erosion or flooding hazards in adjacent or downcoast areas.

d. Encourage and support local flood plain zoning and other management of hazardous areas in all coastal towns.

Policy (9) Ensure that state and federally funded public works projects proposed for location within the 100-year coastal flood plain will:

a. not exacerbate existing hazards or damage natural buffers,

b. be reasonably safe from flood and erosion related damage, and

c. not promote growth and development in damage prone or buffer areas, especially in undeveloped areas of APR's.

Policy (10) Acquire undeveloped hazard prone areas for conservation or recreation use.

Policy (11) Provide funding and technical assistance for the restoration and stabilization of foreshore and shore areas in hazardous zones using nonstructural measures.

Policy (12) a. Implement federal or state structural solutions to protect property and lives only when there will be widespread public benefits and minimal adverse environmental effects.

b. Approve permits for private flood or erosion control projects only when it has been determined that there will be no adverse effects on adjacent properties or down coast areas.

Major inland floods in the region have been the result of hurricane storms which dump great volumes of water over a 2 or 3-day period or late winter rains which fall on frozen ground or snow, resulting in relatively large runoff volumes. The larger recent hurricane storms of September 17-22, 1938 and August 17-20, 1955 caused extensive flooding and damage throughout the region. Recent late winter storms which caused extensive inland flooding were in March 17-20, 1936 and March 17-20, 1968. In the Thames and Assabet River Basins, the Diane hurricane flood of August 1955 remains the largest recorded flow. For the other basins in the region, however, the storms of March 1968, September 1938 or March 1936 produced record flood discharges. The 1968 and 1936 floods were caused by heavy rains on ice and snow. For most basins these flows were the greatest since at least 1886, the year of another great winter flood.

The hurricane storm of August 17-20, 1955 produced from 4 to 17 inches of rainfall in the region, while the late winter storm of March 17-20, 1968 produced from 2 to 5 inches of rain in the region. Peak flows however, were comparable in many basins. This shows the dominating effect of existing conditions when a storm occurs.

The isohyetal map (Figure 5.7) shows the precipitation which occurred during the "Hurricane Diane" storm of August 17-20, 1955. This information was taken from U.S. Weather Bureau, Technical Paper No. 26, Hurricane Rains and Floods of August 1955 Carolinas to New England.

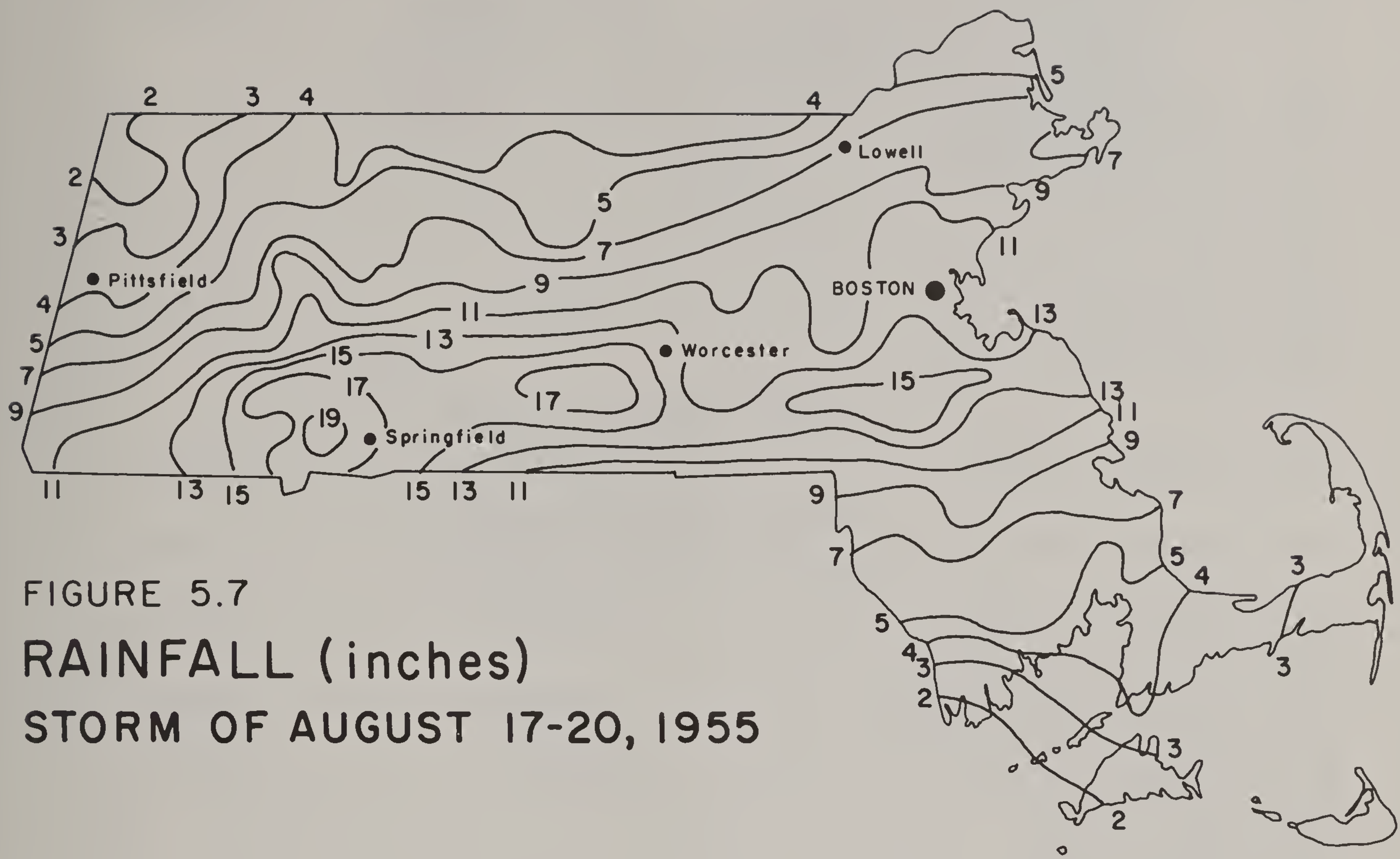

FIGURE 5.7

RAINFALL (inches)

STORM OF AUGUST 17-20, 1955

Hurricane Diane, storm of August 17-20, 1955, was one of the most intense storms that has occurred in the region, and it occurred only 1 week after Hurricane Connie which deposited 3 to 6 inches of rain. Thus, when Hurricane Diane struck, wetlands were already saturated and streamflows were above normal.

Field investigations made by the Soil Conservation Service indicate that average annual inland flood damage in the region, excluding the main stem Merrimack River, exceeds $4,900,000 and that a 100-year frequency flood would cause damage in excess of $80 million. Average annual damages and damages expected from a 100-year flood in each of the region's subwatersheds are summarized in Table 5.11 and depicted geographically on Figure 5.8.

TABLE 5.11 PRESENT FLOOD DAMAGES 1/

Subwatershed	100-Year Flood Damage	Average Annual Damage
-Merrimack River Watershed- 2/		
ME-1 (Rowley River)		3/
ME-12 (Cow Pond Brook)		3/
ME-13 (Merrimack River)		3/
ME-14 (Stony Brook)		3/
ME-15 (Merrimack River)	$1,144,300	$68,700
ME-18 (River Meadow Brook)		3/
ME-19 (Shawsheen River)	1,242,000	74,500
ME-20 (Merrimack River)		3/
ME-21 (Merrimack River)		3/
-Concord River Watershed-		
CO-17 (Concord River)	805,000	48,300
-Assabet River Watershed-		
AS-17 (Assabet River)	112,700	6,800
-Blackstone River Watershed-		
BL-61 (Ramshorn Brook)	285,200	17,100
BL-62 (Blackstone River)		3/
BL-63 (Quinsigamond River)	363,400	21,800
BL-64 (Blackstone River)	958,000	57,500
BL-65 (Mumford River)	2,066,000	124,000
BL-66 (West River)		3/
BL-67 (Mill River)		3/
BL-68 (Abbott Run)		3/
-Thames River Watershed-		
TH-1 (Furnace Brook)		3/
TH-1A (Quinnebaug River)	844,100	50,600
TH-2 (French River)		3/
-Sudbury River Watershed-		
SU-16 (Baiting Brook)	714,500	146,900
SU-17 (Sudbury River)	9,058,300	543,500
-Nashua River Watershed-		
NA-1 (Souhegan River)		3/
NA-2, 3, & 4 (North Nashua River)	62,183,000	3,685,000
NA-5 (Quinapoxet River)		3/
NA-6 (Stillwater River)		3/
NA-7 (Nashua River)	201,300	12,100
NA-8 (Catacoonamug Brook)	115,000	6,900
NA-9 (Mulpus Brook)		3/
NA-10 (Squannacook River)	227,700	13,700
NA-11 (Nashua River)	281,700	16,900

1/ Price Base 1976.
2/ Does not include main stem damage.
3/ Average Annual Damage less than $5,000.

LEGEND

- LESS THAN $5,000 (red hatching)
- $5,000 to $100,000 (pink stipple)
- OVER $100,000 (blank)

NOTES

1. DAMAGE FIGURES PRESENTED BY SUBWATERSHEDS
2. DOES NOT INCLUDE MAIN STEM MERRIMACK RIVER DAMAGES

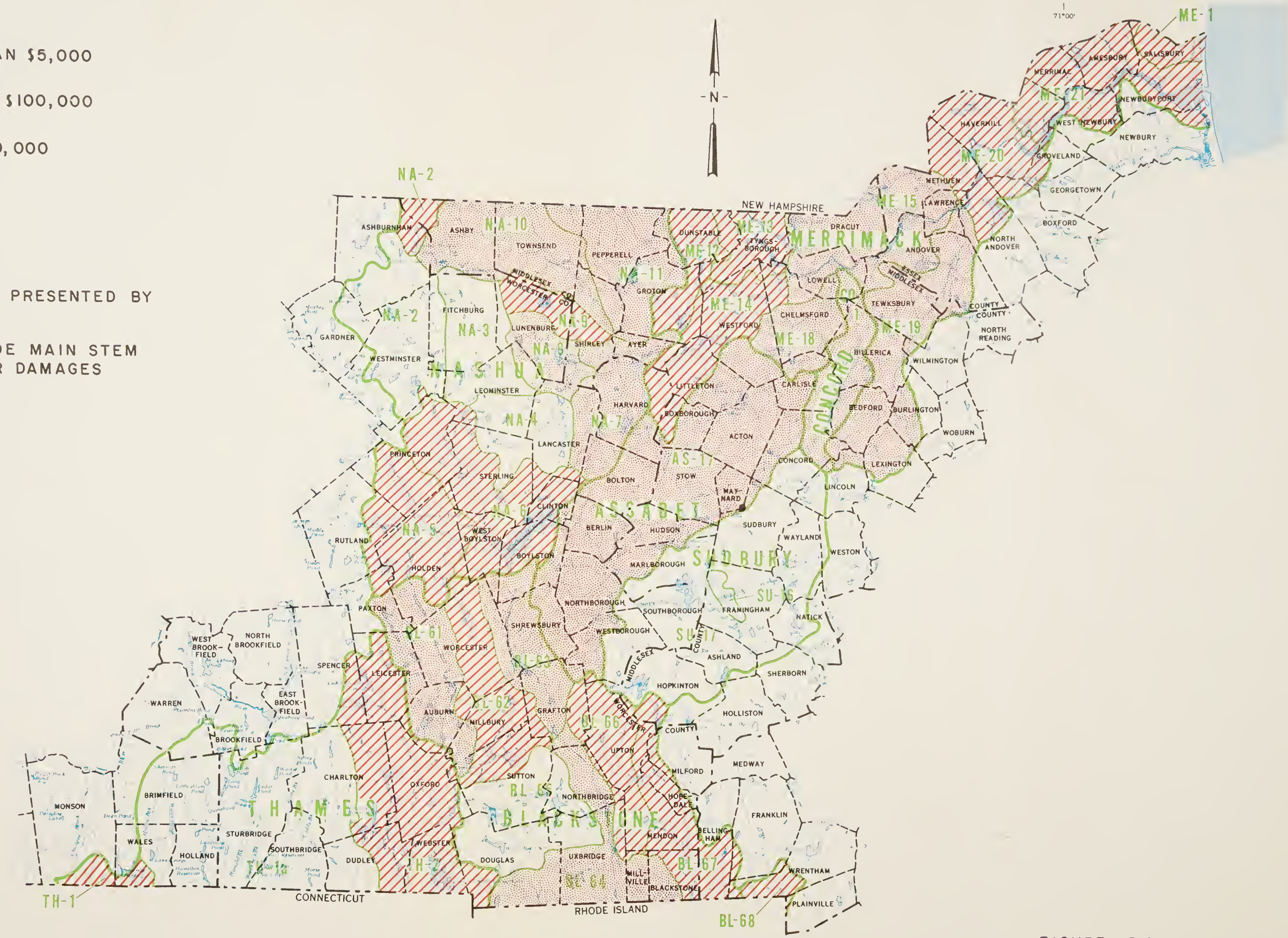

FIGURE 5.8

AVERAGE ANNUAL FLOOD DAMAGE

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Historically, many industries were located on flood plains because water was necessary for plant operations. The alternative of developing above the flood plains was more costly since it meant substituting more expensive methods of generating power, discharging waste products and cooling. Roads were developed on flood plains because of lower installation costs--it was less expensive to build on the flat valley lands than to route highways over upland terrain. Residential building upon flood plains also resulted from the lower comparative costs. In addition much residential development was stimulated by the existing industrial flood plain development, i.e., housing for factory workers was often located in close proximity to their employment.

In flood plain development, one significant cost determinant was often excluded from the decision-making process--this being the cost of flood damage. In some instances, the flood hazard was not recognized. In others, the hazard was recognized but the severity was misjudged. In still other cases, federal disaster assistance after the flood encouraged rehabilitation of flood damaged property in the same location.

Floods cause damage to many properties which have been developed in wetlands or flood prone areas. Many of the property owners do not consider themselves to be in a flood prone area. The 1968 Post Flood Report for the Flood of March 18-25, 1968 in New England, summed the problem as follows:

> Many of the developments are some distance from major streams and the threat of flooding was not apparent. Moreover, the first half of the 1960 decade was a time of drought in the northeast and this tended to mask the problem as ground water levels were at record lows during the period. With the return to normal levels in 1967, the area needed only a major storm with rapid runoff to be in real trouble.

The filling of wetlands and encroachment on the flood plains for development not only endangered the developed area itself, but compounded problems downstream. As a wetland is filled, its ability to reduce flood peaks by storing water for later release is diminished. Filling or blocking the flood plains also increased peak flows downstream, but even more important, it causes greater depths of flow and higher velocities for any given flood. In addition, the conversion of marshland and vegetation to buildings and paved parking lots results in an increased volume of runoff for an equal amount of rainfall.

5.4 EROSION AND SEDIMENT

General -- Soil erosion results from the action of moving water, wind, gravity, frost or a combination of these forces on the land. The main concerns in this region are water-activated erosion and its by-product--

sedimentation. In addition, natural or geologic erosion should be differentiated from accelerated erosion.

> "Natural or geologic erosion is a continuing process and will go on into the future regardless of anything man can do. Quickening of the pace of erosion, owing to changes wrought by man, has produced definitely abnormal conditions. Accelerated erosion, and abnormal and undesirable process, was started by man's activities and is subject to his control."[10/]

Sheet, rill, gully, stream and roadbank erosion occur in the region; but, in general, the erosion rate is low in comparison to the southern or western portions of the country.

Erosion is not only a problem in itself, but also serves as a source for sediment. Once erosion has taken place, the eroded material will usually create a second problem when deposited downstream in stream channels, reservoirs, lakes, wetlands and rivers. Along with the individual soil particles which constitute sediment, any fertilizer, pesticide, animal waste or other organic matter attached or adjacent to the soil particles, is also carried off. Some of this also reaches streams and results in a lowering of water quality.

Erosion and sediment problems have historically been corrected with land treatment measures which are the application of a combination of practices that will meet specific objectives. These objectives include controlling soil erosion, decreasing runoff of rainfall, improving soil and plant productivity, improving wildlife habitat, and improving environmental quality. The practices are classified as managerial, vegetative and cultural, or mechanical.

Mechanical practices include diversions, terraces, waterways, outlets, and small grade stabilization structures. These practices are designed to reduce erosion by reducing the length of slope and by providing proper courses for transporting the water at nonerosive velocities. When used with vegetative practices, mechanical practices can be extremely effective in reducing erosion.

Examples of vegetative and cultural practices are: conservation cropping systems, minimum tillage, cover cropping, contour strip cropping and planting of grasses, legumes, proper grazing use, and shrubs and trees on critical areas. These practices protect the soil from the impact of raindrops, reduce runoff and reduce the contact between soil particles and flowing water.

Timber stand improvement, timely field operations, recreation and wildlife area management, and maintenance operations are all examples of managerial practices. These practices minimize the overuse of the land while at the same time improve the condition of the cover.

As mentioned, land treatment is planned for other objectives besides erosion control, but adequate protection of the soil is of primary importance. Land treatment has been found to be as effective in urban applications as it is in the rural sector.

In addition to land treatment, land use planning and structural measures are also applied to minimize erosion. Land use planning can be developed to guide the use, growth and development of land in the cities and towns. Land subject to excessive erosion can be converted to other land uses which have a lower erosion rate. Areas, such as flood plains and steep slopes, can be managed to reduce erosion and sediment damage.

Structural measures can be designed and used to protect the land from erosion and sediment. Some of the appropriate measures are debris basins, riprapping, channel improvements, and large grade stabilization structures. Erosion and sedimentation can be reduced by decreasing high stream flows with flood control measures. Impoundments and natural storage basins will also collect the sediment in the stream and reduce sediment deposits downstream. The water quality in the stream should also be improved by reducing sediment loads.

Erosion -- To assess the extent of the erosion and sediment problems in the Central Region, the area was divided into three types based on its general susceptibility to erosion. These "Erosion Land Types" were: (1) upland, (2) terrace and, (3) flood plain. Location and extent of the types are shown on Figure 5.9.

Potential erosion problem areas were listed to insure that all categories of erosion were considered. Based on the judgement of Soil Conservation Service field technicians, the following types of areas were thought to represent the major erosion potential: farmland in cultivation, logging roads and skid trails, roadbanks, unpaved roads, gravel pits, construction areas, streambanks, and utility rights-of-way.

These potential erosion problems were studied using a sampling basis to determine the extent of the erosion. Samples were made in each of the three "Erosion Land Type" areas. Soil Conservation Service technicians visited known problem areas to quantify the erosion. Gravel pits and construction areas were also selected based on known problems or areas which appeared to have potential problems. Forest land erosion rates were estimated by Forest Service personnel. Erosion from roadbanks, unpaved roads, streambanks and utility rights-of-way was estimated by inventorying the problems noted along a specified length of sample reach.

These erosion samples and case studies formed the basis for calculating erosion rates for the various problem types in each "Erosion Land Type." The MacConnell's Massachusetts Map Down series was used to determine the

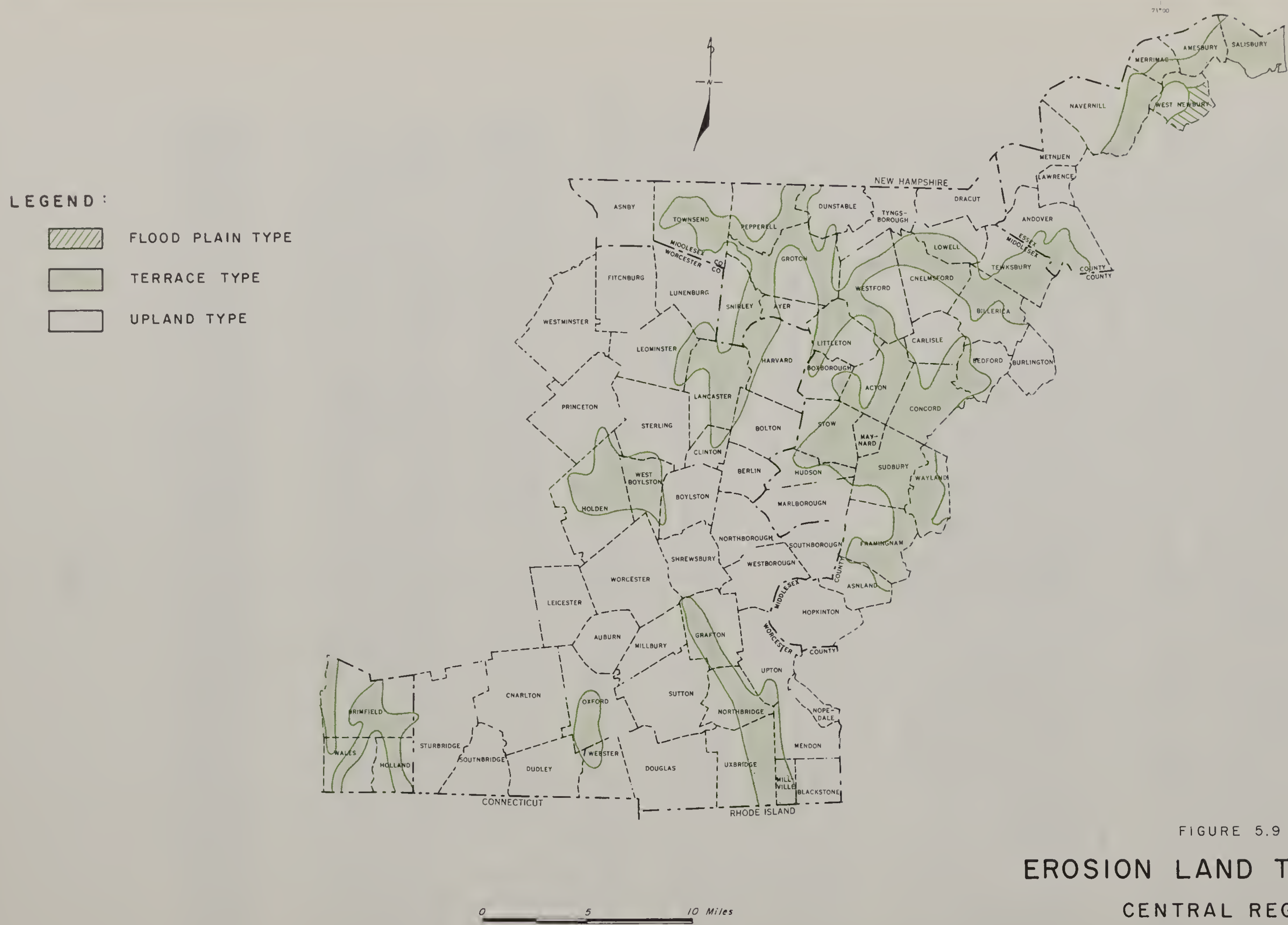

FIGURE 5.9

EROSION LAND TYPE MAP

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

number of acres in various land uses in each "Erosion Land Type." Total erosion estimates for the Central Region are presented in Table 5.12.

Gravel pits and earth removal operations with their disruption of vegetation and steep slopes were thought to be potential erosion and sediment problems. Examination showed that although erosion of side slopes was indeed a severe problem in terms of the volume of soil being moved, in most instances, little or no material left the actual gravel pit thus eliminating the offsite sediment problem. It seems that what appeared to be a major source of sediment was rarely a problem beyond the limits of the removal operation. Field examination showed that erosion of roadbanks was also a minor problem.

Regulations are the probable reason for gravel pits being a minor element of the total erosion picture. Over 85 percent of the communities in the region have bylaws which regulate gravel pits and earth removal activities. These communities are shown on Figure 5.10.

TABLE 5.12 CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acre)	Annual Erosion (tons)
Central Region			
1. Tilled Cropland	12,504	(6.4)	79,085
2. Other Agricultural Land	90,574	(0.26)	23,758
2.1 Orchards, bushfruit and nurseries	9,078	0.25	2,252
2.2 Pasture, hayland and unused tilled cropland	81,496	(0.26)	21,506
3. Other lands (abandoned fields and orchards, etc.)	44,074	0.25	11,105
4. Forest (does not include wooded swamps)	601,724	0.2	108,817
5. Wetlands, wooded swamps (non-sediment producing)	84,548	0	0
6. Urban	213,212	0.3	64,136
7. Construction Sites (annual)	6,392	39.	251,763
LAND EROSION TOTAL	1,053,028	(0.5)	538,664
8. Streambanks susceptable to erosion	(miles)	(tons/mile)	
Major Streams	139	210	29,252
Tributaries	168	453	76,048
TOTAL EROSION			643,964

TABLE 5.12 - cont. CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acre)	Annual Erosion (tons)
Essex County			
1. Tilled Cropland	1,470	(6.2)	9,102
2. Other Agricultural Land	9,510	(0.2)	2,008
2.1 Orchards, bushfruit and nurseries	744	0.2	149
2.2 Pasture, hayland and unused tilled cropland	8,766	.2	1,859
3. Other lands (abandoned fields and orchards, etc.)	4,814	0.2	963
4. Forest (does not include wooded swamps)	37,227	0.15	5,584
5. Wetlands, wooded swamps (non-sediment producing)	8,324	0	0
6. Urban	30,598	0.3	9,179
7. Construction Sites (annual)	750	39.0	29,250
LAND EROSION TOTAL	92,693	(0.6)	56,086

Land Use	Area (acres)	Annual Erosion Rate (tons/acre)	Annual Erosion (tons)
Hampden County			
1. Tilled Cropland	441	(5.9)	2,592
2. Other Agricultural Land	2,281	(0.2)	456
2.1 Orchards, bushfruit and nurseries	126	0.2	25
2.2 Pasture, hayland and unused tilled cropland	2,155	0.2	431
3. Other lands (abandoned fields and orchards, etc.)	1,650	0.2	330
4. Forest (does not include wooded swamps)	31,625	0.2	6,325
5. Wetlands, wooded swamps (non-sediment producing)	1,762	0	0
6. Urban	1,731	0.4	692
7. Construction Sites (annual)	75	72.	5,400
LAND EROSION TOTAL	39,565	(0.)	15,795

TABLE 5.12 - cont. CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acre)	Annual Erosion (tons)
Middlesex County			
1. Tilled Cropland	4,878	(6.1)	29,546
2. Other Agricultural Land	29,109	(0.2)	6,264
2.1 Orchards, bushfruit and nurseries	3,745	0.2	739
2.2 Pasture, hayland and unused tilled cropland	25,364	0.2	5,525
3. Other lands (abandoned fields and orchards, etc.)	14,718	0.2	2,944
4. Forest (does not include wooded swamps)	193,328	0.15	28,999
5. Wetlands, wooded swamps (non-sediment producing)	35,811	0	0
6. Urban	86,679	0.3	26,004
7. Construction Sites (annual)	2,808	39.0	109,512
LAND EROSION TOTAL	367,331	(0.5)	203,269
Worcester County			
1. Tilled Cropland	5,715	(6.6)	37,845
2. Other Agricultural Land	49,674	(0.3)	15,030
2.1 Orchards, bushfruit and nurseries	4,463	0.3	1,339
2.2 Pasture, hayland and unused tilled cropland	45,211	0.3	13,691
3. Other lands (abandoned fields and orchards, etc.)	22,892	0.3	6,868
4. Forest (does not include wooded swamps)	339,544	0.2	67,909
5. Wetlands, wooded swamps (non-sediment producing)	38,651	0	0
6. Urban	94,204	0.3	28,261
7. Construction Sites (annual)	2,759	39.	107,601
LAND EROSION TOTAL	553,439	(0.5)	263,514

LEGEND:

COMMUNITIES WITH BY-LAWS TO REGULATE GRAVEL PIT & EARTH REMOVING ACTIVITIES IN 1977.

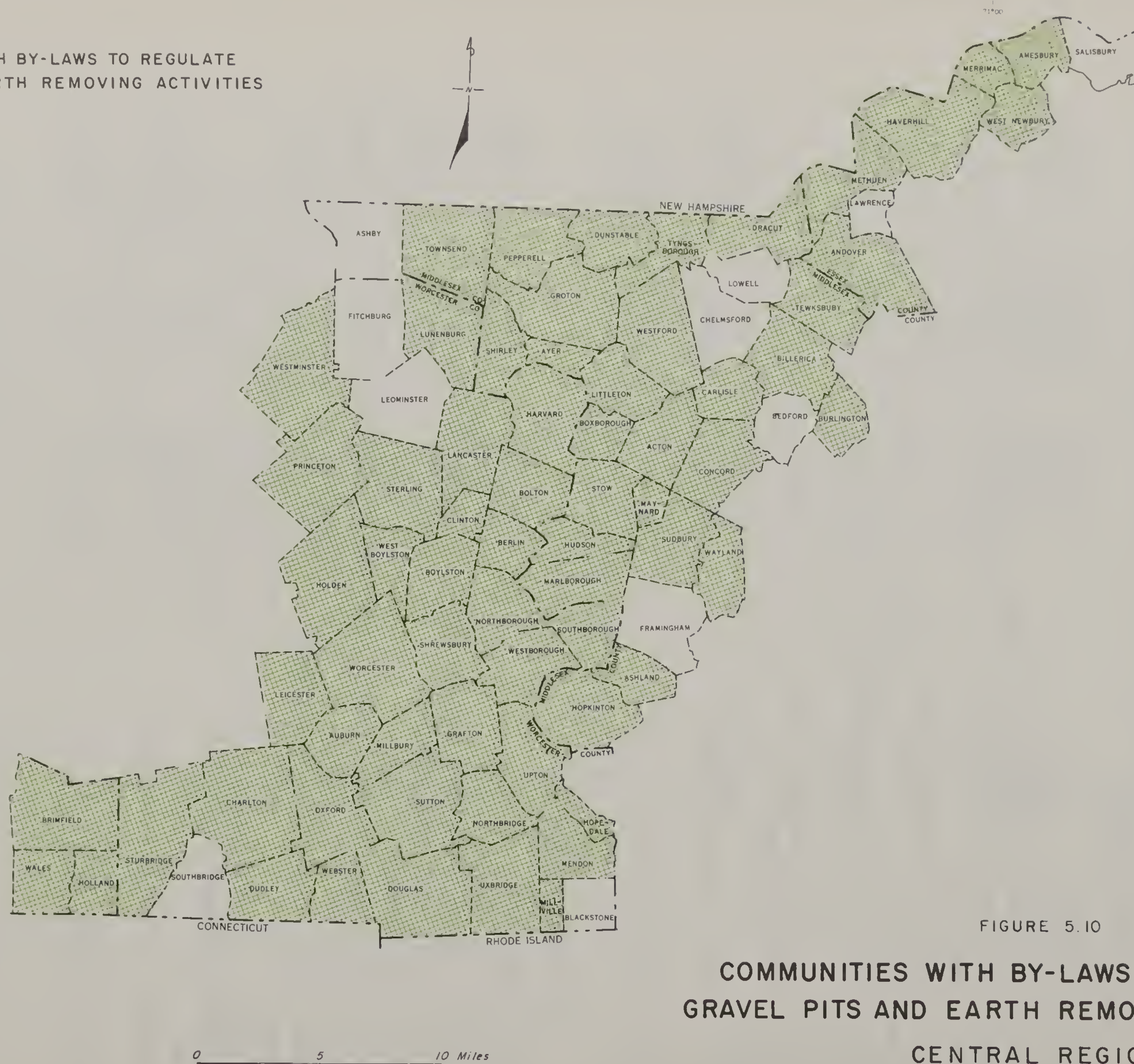

FIGURE 5.10

COMMUNITIES WITH BY-LAWS TO REGULATE GRAVEL PITS AND EARTH REMOVING ACTIVITIES

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
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The bylaws and regulations are designed to limit the offsite effects of earth removal activities and seem quite successful in accomplishing their intended purpose.

Erosion along roadways was found to be a minor problem in the region; however, isolated severe cases of roadbank erosion exist. But when they are found, they represent a small percentage of the total roadbank mileage.

Total gross erosion from developed urban areas is relatively low (64,000 tons per year). This is because in stabilized urban areas almost all of the land surface is covered with roofs, asphalt or other paving, or permanent vegetation. The annual erosion rate of urban land is estimated at 0.3 tons per acre.

The areas with the highest erosion rates were found to be areas which were under construction. The average erosion rate for construction sites was estimated to be 39 tons per acre. This figure varies enormously depending on such factors as site topography, slope, construction practices, and time of year. Construction areas have the highest rates of erosion since, by their very nature, they involve the removal of protective vegetation and exposure of bare soil to the effects of wind and, more importantly, water.

Erosion control practices during construction can do much to reduce the rate and extent of erosion. The Soil Conservation Service has prepared a publication entitled "Guidelines for Soil and Water Conservation in Urbanizing Areas of Massachusetts" which details some of these erosion control practices that can be utilized on construction. Erosion control measures during construction add minimally to the total construction cost, however, many contractors and owners are reluctant to spend money for "nonconstruction" type measures. Many communities have some minor control on erosion during construction through zoning, building or other bylaws. This method is not very effective and fails to cover many aspects of the problem. Only one or so communities actually have adequate and effective sediment and erosion control bylaws.

The regional average erosion rate of tilled cropland is 6.4 tons per acre per year. Soil scientists estimate that to maintain productivity over time, annual soil losses on most of Massachusetts' agricultural soils must be limited to no more than 3 tons per acre. So at present the average erosion rate of tilled cropland is over two times this maximum annual rate. Erosion on about 80 percent of this tilled land is less than the tolerable annual soil loss. The high average is from excessive losses on less than 20 percent of the tilled land and is the result of poor management. On certain individual farms sampled annual erosion rates of over 80 tons per acre were computed for field corn. Worcester and Middlesex Counties account for approximately 85 percent of the tilled cropland erosion in the region.

Establishment and maintenance of good conservation practices by the majority of the region's farm operators has done much to reduce total erosion from farmland. However, more needs to be done by the minority of farmers who have erosion problems on their land.

Sampling and surveys have shown that erosion from wetlands, hayland, pasture, forest, orchards, abandoned fields, and established urban areas is not a serious matter.

Streambank erosion is a problem in the region. Although the total volume of streambank erosion is only 16 percent of the total erosion, a far greater proportion, over 50 percent, of the streambank erosion ends up as sediment in streams, lakes, ponds, or rivers.

Sediment -- If the entire volume of erosion in the region were to result in sediment which was delivered to streams and rivers, the results would be catastrophic. Fortunately, a large percentage of the erosion products from land areas are deposited on land before reaching a watercourse. Stone walls, fences, strips of vegetation, forest land, and even flat slopes cause the erosion products to be deposited. Delivery rates of sediment to streams may be 10 percent or less of the original eroded volume.

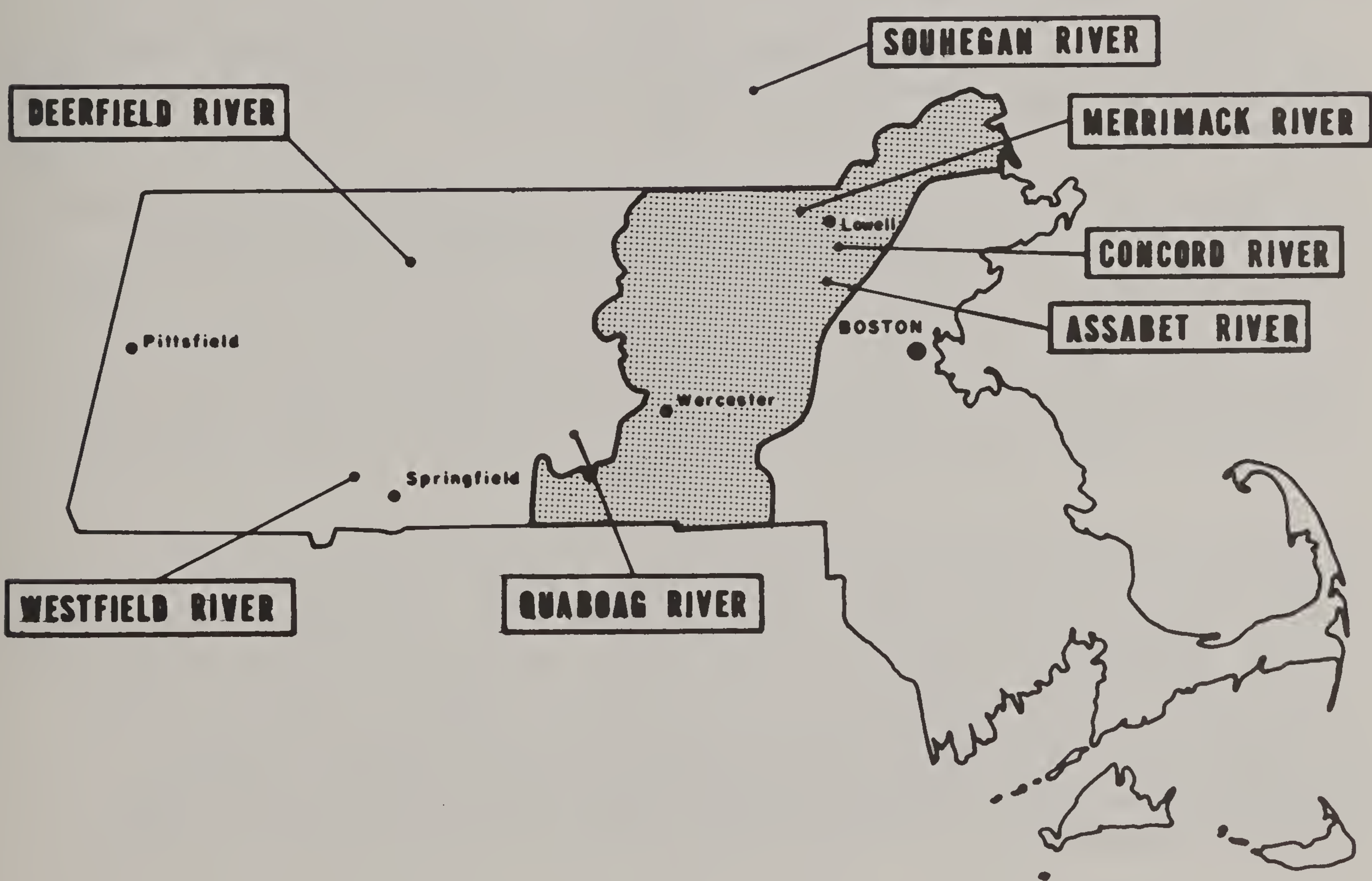
On the other hand, erosion from streambanks results in a very high percentage of eroded material becoming sediment. Cobbles and boulders usually remain fairly close to their original location, sand may settle out in the flat stretches of streams and in pools, but the fine sand and silt fraction remains as suspended sediment to dirty the water and reduce its value as fish habitat and as habitat for insects in the fish food-chain.

Suspended sediment measurement stations have been established throughout Massachusetts by the U.S. Geological Survey. These stations are located on major streams and monitor suspended sediment at the USGS stream gage locations. Station locations and pertinent data are shown on the map accompanying Table 5.13. Flow-duration data combined with suspended sediment readings were used to prepare average annual sediment data for each station.

The results of the average annual sediment calculations are presented in Table 5.13. Although the data has significant scatter when plotted, it does present a rough idea of values to be expected for the suspended sediment.

TABLE 5.13 SEDIMENT ESTIMATES AT SELECTED STREAM GAGES

Stream Gage	Drainage Area (sq miles)	Suspended Sediment (tons/sq mile)	Total Sediment (tons/sq mile)
Merrimack River above Lowell, Mass.	4635	53.1	55.8
Concord River at Lowell, Mass.	405	13.0	15.7
Assabet River at Maynard, Mass.	116	7.4	10.1
Souhegan River New Hampshire	171	2.1	23.7
Westfield River near Westfield, Mass.	497	81.9	84.6
Deerfield River near W. Deerfield, Mass.	558	49.2	51.9
Quaboag River at W. Brimfield, Mass.	151	12.9	15.6



The range of values is between 0.015 tons/acre and 0.155 tons/acre. There appears to be little correlation between the size of drainage area and the amount of suspended sediment per unit area. Factors such as upstream wetlands and dams which act as sediment traps, and effluents from sewage treatment plants are responsible for much of the scatter in the data.

Based on the analysis of suspended sediment data and estimates of quantities of the larger sized "bedload" sediment, it is estimated that total annual sediment in the rivers and streams of the region is approximately 64,000 tons or about 10 percent of the total erosion in the region.

5.5 WETLANDS

Wetlands are those areas where the water table is at or near the ground surface for much of the year and are subject to occasional flooding. In the Central Region, wetlands include swamps, marshes, bogs, beaver ponds, salt marshes, salt meadows, seasonally flooded flats, and wet meadows. The soils of the wetlands are usually poorly or very poorly drained, except for beaver ponds and seasonally flooded flats. The latter are usually alluvial or flood plain soils which may have better drainage.

There are 2,527 acres of coastal wetlands, salt marshes and salt meadows, as mapped by MacConnell et al., in the region, all in the town of Salisbury.

Approximately 2,400 acres of these tidal wetlands in Salisbury are protected from development by restriction under the Massachusetts Coastal Wetlands Restriction Act, G.L. Ch. 130, Sec. 105.

See Table 5.14 Inland Wetlands, Regional Summary, and Table 5.15 Inland Wetlands Areas, which lists inland wetland acreage of the region's municipalities. The wetland figures do not include flood plain lands that are dry most of the year although these usually dry portions of flood plains are in the same jurisdictional category as wetlands in Massachusetts wetland legislation. The approximately 82,000 acres of inland wetlands in the region represents 7.5 percent of the total area. The range is from 0.4 percent in Fitchburg to 19.2 percent in Sudbury.

Wetlands are important for flood control, wildlife habitats, and to a lesser degree for water quality and ground water aquifer protection. Wetlands are extremely poor sites for industrial, commercial, and residential development because of high water tables, flooding hazards, and the possibility of having non-stable organic materials in the soils underlying building foundations. High water tables eliminate the use of septic tank and leach field systems for onsite sewage disposal, create serious site drainage problems, and make the use of building basements impractical and often impossible. The presence of organic

TABLE 5.14 INLAND WETLANDS REGIONAL SUMMARY

	Open Type 1/ (acres) 2/	Wooded Swamps 3/ (acres)	Total (acres)	Fresh Open Water 4/ (acres)	Grand Total (acres)
Merrimack	6,377	8,854	15,231	4,285	19,516
SuAsCo	9,134	18,082	27,216	6,553	33,769
Nashua	4,382	14,640	19,022	10,579	29,601
Blackstone	3,583	7,175	10,758	4,437	15,195
Thames	2,218	7,574	9,792	5,870	15,662
Totals	25,694	56,325	82,019	31,724	113,743

1/ Data obtained from Massachusetts Map Down Project at University of Massachusetts, directed by Prof. William P. MacConnell.

2/ These open type wetlands, as mapped by MacConnell, et al., are based on the wetlands classification presented in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. The Massachusetts Map Down wetland types included in the open type wetlands column above and the equivalent wetland type of the U.S. Fish and Wildlife Service, Circular 39, are as follows: Seasonally flooded basins or flats--Type 1; Bog--Type 8; Shrub Swamp--Type 6; Meadow--Type 2; Shallow Marsh--Type 3; Deep Marsh--Type 4; Beaver Pond--Type 3 or 4.

3/ Measured by the Soil Conservation Service. This is equivalent of Type 7, Circular 39.

4/ This is equivalent of Type 5, Circular 39.

TABLE 5.15 WETLAND AREAS

Municipality	Open 1/2/ Wetlands (acres)	Wooded 3/ Swamps (acres)	Total Inland Wetlands (acres)	Total % of Municipal Area	Fresh 4/ Open Water (acres)	Grand Total (acres)	Grand Total % of Municipal Area
Merrimack Study Area							
Amesbury	368	311	679	7.7	525	1,204	13.6
Andover	575	845	1,420	6.9	586	2,006	9.7
Burlington	126	362	488	6.5	0	488	6.5
Chelmsford	632	427	1,059	7.0	238	1,297	8.5
Dracut	141	517	658	4.9	251	909	6.7
Dunstable	352	945	1,297	12.0	82	1,379	12.7
Haverhill	469	766	1,235	5.4	764	1,999	8.7
Littleton	378	592	970	8.6	535	1,505	13.3
Lowell	83	18	101	1.1	0	101	1.1
Lawrence	22	31	53	1.1	18	71	1.5
Merrimac	103	238	341	6.0	13	354	6.2
Methuen	550	437	987	6.7	96	1,083	7.4
Salisbury	242	69	311	2.8	0	311	2.8
Tewksbury	482	1,236	1,718	12.5	145	1,863	13.6
Tyngsborough	361	273	634	5.7	328	962	8.6
Westford	948	1,561	2,509	12.6	499	3,008	15.1
W. Newbury	545	226	771	8.1	205	976	10.3
Subtotal	6,377	8,854	15,231	7.2	4,285	19,516	9.3
Nashua Study Area							
Ashby	80	153	233	1.6	294	527	3.6
Ayer	260	158	418	6.9	280	698	11.6
Boylston	85	1,025	1,110	8.9	2,293	3,403	27.4
Clinton	22	33	55	1.2	1,023	1,078	23.3
Fitchburg	25	56	81	0.4	201	282	1.6
Groton	604	1,647	2,251	10.4	447	2,698	12.4
Harvard	612	778	1,390	8.1	387	1,779	10.3
Holden	263	1,038	1,301	5.6	775	2,076	9.0
Lancaster	301	1,350	1,651	9.2	733	1,884	10.4
Leominster	145	519	664	3.5	540	1,204	6.3
Lunenburg	435	1,245	1,680	9.4	989	2,669	15.0
Pepperell	204	843	1,047	7.1	28	1,075	7.3
Princeton	189	1,726	1,915	8.4	115	2,030	8.9
Shirley	199	809	1,008	10.5	14	1,022	10.6
Sterling	282	926	1,208	6.0	842	2,050	10.2
Townsend	204	1,094	1,298	6.2	87	1,385	6.6
W. Boylston	61	288	349	3.9	714	1,063	11.9
Westminster	411	952	1,363	5.7	1,315	2,678	11.2
Subtotal	4,382	14,640	19,022	6.5	10,579	29,601	10.1
Thames Study Area							
Brimfield	314	742	1,056	4.6	337	1,393	6.1
Charlton	145	1,798	1,943	7.0	890	2,833	10.2
Dudley	285	507	792	5.7	555	1,347	9.6
Holland	85	264	349	4.3	430	779	9.7
Leicester	72	1,034	1,106	7.0	931	2,037	13.0
Oxford	394	807	1,201	6.9	328	1,529	8.7
Southbridge	153	505	658	5.0	218	876	6.6
Sturbridge	388	1,397	1,785	7.1	818	2,603	10.4
Wales	84	273	357	3.7	136	493	5.0
Webster	298	247	545	5.9	1,227	1,772	19.1
Subtotal	2,218	7,574	9,792	6.0	5,870	15,662	9.6

TABLE 5.15 - cont. WETLAND AREAS

Municipality	Open 1/2/ Wetlands (acres)	Wooded 3/ Swamps (acres)	Total Inland Wetlands (acres)	Total % of Municipal Area	Fresh 4/ Open Water (acres)	Grand Total (acres)	Total % of Municipal Area
Blackstone Study Area							
Auburn	101	259	360	3.4	640	1,000	9.6
Blackstone	138	294	432	6.0	194	626	8.7
Douglas	324	1,684	2,008	8.2	740	2,748	11.2
Grafton	572	633	1,205	8.2	193	1,398	9.5
Hopedale	172	131	303	9.0	40	343	10.2
Mendon	252	873	1,125	9.8	115	1,240	10.8
Millbury	286	343	629	6.1	233	862	8.4
Millville	66	154	220	6.9	3	223	7.0
Northbridge	347	358	705	6.0	415	1,120	9.6
Sutton	327	885	1,212	5.5	862	2,074	9.4
Upton	335	566	901	6.5	116	1,017	7.4
Uxbridge	564	823	1,387	7.2	372	1,759	9.2
Worcester	99	172	271	1.1	514	785	3.2
Subtotal	3,583	7,175	10,758	6.1	4,437	15,195	8.6
SuAsCo Study Area (Sudbury, Assabet and Concord							
Acton	483	676	1,159	9.0	200	1,359	10.5
Ashland	68	583	651	7.9	362	1,013	12.3
Bedford	638	870	1,508	16.9	9	1,517	17.0
Berlin	232	263	495	5.9	98	593	7.0
Billerica	537	741	1,278	7.6	113	1,391	8.2
Bolton	209	709	918	7.2	47	965	7.6
Boxborough	206	1,029	1,235	18.5	18	1,253	18.8
Carlisle	278	1,103	1,381	14.0	67	1,448	14.6
Concord	1,070	668	1,738	10.5	539	2,277	13.8
Framingham	212	458	670	4.0	869	1,539	9.1
Hopkinton	298	1,803	2,101	11.7	1,002	3,103	17.3
Hudson	344	223	567	7.4	85	652	8.5
Marlborough	193	661	854	5.9	730	1,584	11.0
Maynard	112	404	516	15.2	53	569	16.8
Northborough	336	1,223	1,559	13.2	100	1,659	14.0
Shrewsbury	197	572	769	5.6	542	1,311	9.5
Southborough	298	468	766	7.8	872	1,638	16.6
Stow	373	1,212	1,585	13.6	221	1,806	15.5
Sudbury	1,174	1,834	3,008	19.2	166	3,174	20.2
Wayland	1,154	715	1,869	18.4	186	2,055	20.2
Westborough	722	1,867	2,589	19.0	274	2,863	21.1
Subtotal	9,134	18,082	27,216	11.0	6,553	33,769	13.6
Region Total	25,694	56,325	82,019	7.5	31,724	113,743	10.4

1/ Data obtained from Massachusetts Map Down Project at University of Massachusetts, directed by Professor William P. MacConnell.

2/ These open type wetlands, as mapped by MacConnell et al., are based on the wetlands classification presented in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. The Massachusetts Map Down wetland types included in the open type wetlands column above and the equivalent wetland type of the U.S. Fish and Wildlife Service, Circular 39, are as follows: Seasonally flooded basins or flats--Type 1; Bog--Type 8; Shrub Swamp--Type 6; Meadow--Type 2; Shallow Marsh--Type 3; Deep Marsh--Type 4; Beaver Pond--Type 3 or 4.

3/ Measured by the Soil Conservation Service. This is equivalent of Type 7, Circular 39.

4/ This is equivalent of Type 5, Circular 39.

MASS. DIV. OF FISHERIES & WILDLIFE PHOTO

material--muck or peat--in a foundation often results in differential settlement and cracking of the structure or fill. Removal of mucks and peats, particularly deep deposits, is usually a necessity for all but the lightest of fills or structures.

Wetlands act as natural floodwater retarding basins which store floodwaters and, thus, lower downstream peak flood flows. Loss of these storage areas can result in higher flood peaks and more extensive flooding downstream.

Many wildlife species depend directly on wetlands for food and habitat. As a result, wetlands provide many opportunities for recreational activities such as hunting and wildlife observation.

Stream water quality can be either adversely or advantageously modified by wetlands. An example of adverse modifications can occur when wetland aquatic plants including algae, die and decay. During this decomposition, dissolved oxygen can be lowered to inadequate levels to sustain fish and other aquatic animal life. Often, this situation is triggered by nutrient loadings from upstream domestic or industrial waste water effluents. Wetlands can also enhance water quality by acting as sediment traps and nutrient filters. The quality of the incoming water and the condition of the wetland must be known to determine how a particular wetland will effect water quality.

In the region, the major ground water aquifers are usually in the bottom lands or flood plains along or near the major streams. These aquifers are often surfaced by wetlands. A measure of protection to underlying aquifers can be provided by maintaining these wetlands.

Most inland wetlands, during normal or dry periods, act as areas of ground water discharge. During times of flood, however, there is the possibility of recharge into ground water storage areas through their wetlands cover. Also the storing of floodwater in upland wetlands and the releasing of lower flows for a longer period of time from them may allow advantageous recharge conditions to develop downstream.

The Massachusetts Water Resources Study has evaluated 59 of the largest inland wetlands in the Central Region. The wetlands were studied for their value for flood control, timber production, wetland wildlife habitat, recreation, visual quality, and uniqueness. The methodology and criteria employed in the evaluation is discussed in Appendix B. Results of the evaluation are presented in Table 5.16. Figure 5.11 indicates the location of the wetlands which were investigated.

The wetland evaluations are not intended to be used as the sole tool to rank wetlands within the region, nor should a "Low" rated wetland be considered a prime candidate for filling and development. Rather, the ratings can be used to indicate those wetlands which are obviously important

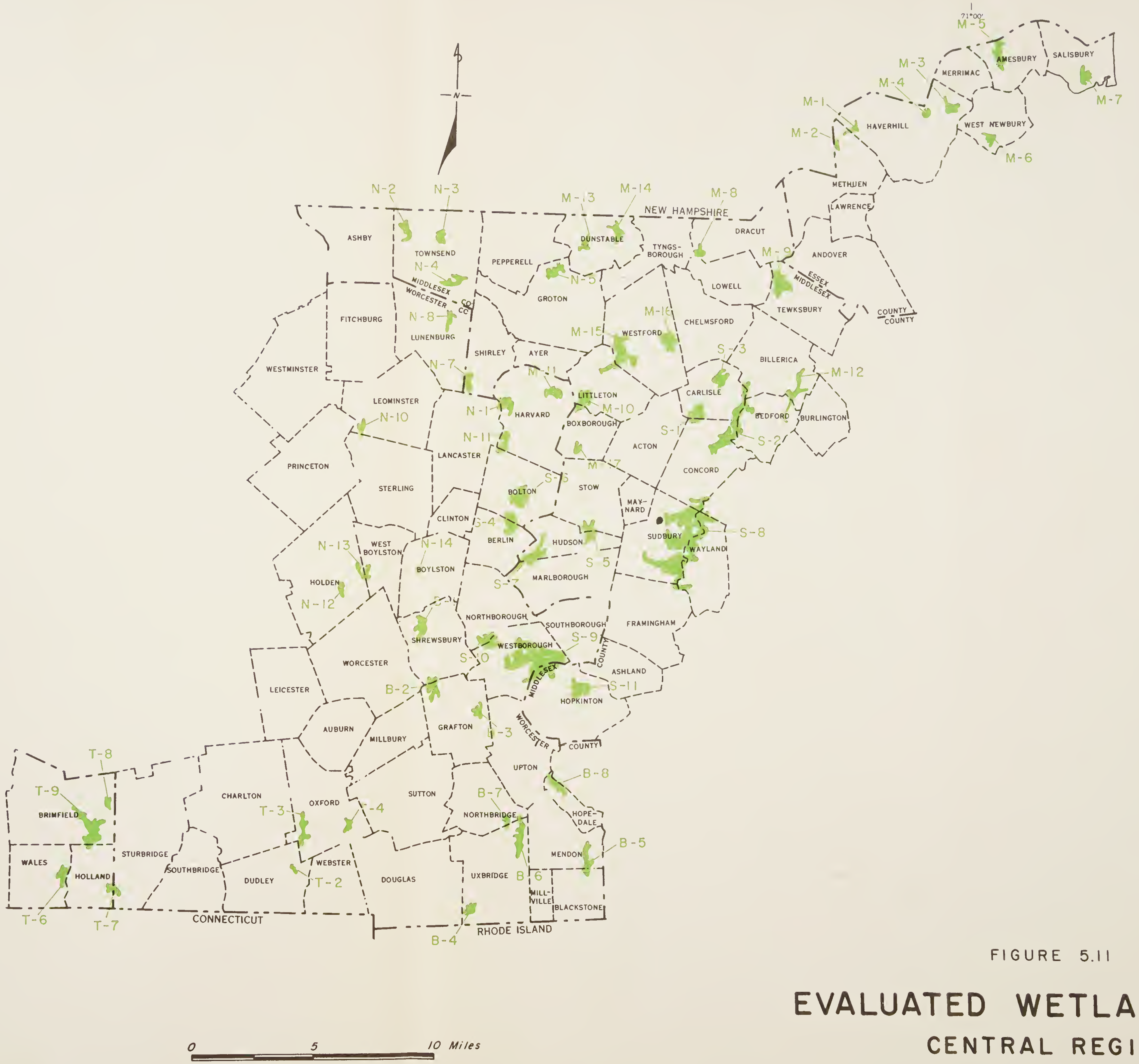


FIGURE 5.11

EVALUATED WETLANDS MAP

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.16

WETLAND EVALUATION RESULTS

Wetland Number	Location Description	Wetland Size (acres)	Wetland Types 1/ (acres) 1	2	3	4	5	6	7	Evaluation Rating for: Forest Manage-ment	Flood Control	Fish Habitat	Wetland Wildlife Habitat	Recre-ation	Unique-ness	Visual Quality
M-1	Ayers Village Wetland, Haverhill	116				6		5	105	High	Mod.	N.R.	Mod.	Low	Low	Mod.
M-2	Crosvenor Corner Wetland, Methuen	138							138	High	Mod.	N.R.	Mod.	Low	Low	Mod.
M-3	East Meadow River Wetland, Haverhill	144				4		24	116	High	Low	N.R.	Mod.	Low	Low	Mod.
M-4	Kenoza Lake Wetland, Haverhill	92			89				3	N.R.	Mod.	N.R.	Low	Low	Low	Mod.
M-5	Pow Wow River Wetland, Amesbury	413		104					309	High	High	N.R.	Mod.	Low	Low	High
M-6	Ash Swamp, West Newbury	157	7	5			5	14	126	High	Mod.	Low	Mod.	Mod.	Low	High
M-7	Town Creek Wetland, Salisbury	110			8			102		N.R.	Low	N.R.	Mod.	Low	High	Mod.
M-8	Spruce Swamp, Dracut	125			3			71	51	High	High	N.R.	Mod.	Low	Low	Mod.
M-9	Great Swamp, Tewksbury	443	20					15	408	High	High	N.R.	Mod.	Low	Low	High
M-10	Beaver Brook Wetland, Littleton	129	23	6	17				83	High	Mod	N.R.	Mod.	Low	Low	Mod.
M-11	Bennetts Brook Wetland, Harvard	142	3		20	3			116	High	High	N.R.	High	Low	Low	High
M-12	Shawsheen River Wetland, Billerica	216			187			6	23	Mod.	Mod.	Low	Mod.	Low	Low	Mod.
M-13	Hawk Swamp, Dunstable	160				4			156	High	Mod.	N.R.	Mod.	Low	Low	Mod.
M-14	Salmon Brook Wetland, Dunstable	107	10		62	2		9	24	High	Low	N.R.	Mod.	Mod.	Low	Mod.
M-15	Beaver Brook Wetland, Westford, Littleton	411	221		20	35		28	107	Mod.	Mod.	N.R.	High	Mod.	Low	High
M-16	Tadmuck Swamp, Westford, Chelmsford	372		4		8		13	347	High	Mod.	N.R.	High	Low	Low	High
M-17	Wolf Swamp, Boxborough	167						2	165	High	Low	N.R.	Mod.	Low	Low	Mod.
S-1	Spencer Brook Wetland, Carlisle, Concord	146	10	8	10				118	High	Mod.	N.R.	Mod.	Low	Low	Mod.
S-2	Concord River Wetland, Concord, Carlisle, Bedford	1373	418		70	180	306	76	323	Mod.	Low	Mod.	High	High	High	High
S-3	Tophet Swamp, Carlisle	167						4	163	High	Mod.	N.R.	Mod.	Low	Low	Low
S-4	Hog Swamp, Berlin, Bolton	277				16		6	255	High	High	N.R.	High	Low	Low	High
S-5	Assabet River - Fort Meadow Brook Wetland, Hudson, Stow	235			1	19		116	99	High	Low	N.R.	High	Mod.	Low	High
S-6	Sunk Meadow, Bolton	178		2					176	High	Mod.	N.R.	Mod.	Low	Low	Mod.
S-7	Assabet River Wetland, Marlborough, Berlin, Hudson	149	20		122			7		N.R.	Mod.	N.R.	Mod.	Low	Low	Mod.
S-8	Sudbury River Wetland, Wayland, Sudbury, Framingham	3436	576		125	9	184	1662	880	High	Mod.	Mod.	High	High	High	High
S-9	Cedar Swamp, Westborough, Hopkinton	1583	36		99	44	17	146	1241	High	High	Mod.	High	High	High	High
S-10	Assabet River Wetland, Westborough, Northborough	333			13			83	237	High	Mod.	N.R.	Mod.	Low	High	Mod.
S-11	Indian Brook Wetland, Hopkinton	359			10	10		3	336	Mod.	Mod.	Mod.	High	Low	High	High
N-1	Nashua River Wetland, Harvard	467		6	76	72		56	257	High	Low	N.R.	High	High	High	High
N-2	Ash Swamp, Townsend	101	16	26				11	48	High	Low	N.R.	Mod.	Low	Low	Mod.
N-3	Meadow Road Wetland, Townsend	159		9					150	High	High	N.R.	Mod.	Low	Low	High
N-4	Squannacook River Wetland, Townsend	168			2	14	23	13	116	High	Low	Mod.	Mod.	Mod.	Low	High
N-5	Reedy Meadow, Groton	296		8		4			284	High	Mod.	N.R.	High	Mod.	Low	High
N-6	Lincoln Pond Swamp, Ashburnham	291					33	48	210	High	Mod.	Mod.	Mod.	Mod.	High	Mod.
N-7	Tophet Swamp, Shirley	142			14			14	114	High	High	N.R.	Mod.	Low	High	Mod.
N-8	Flurcum Swamp, Lunenburg	188			14	52			122	High	Mod.	N.R.	Mod.	Mod.	High	Mod.
N-9	Holbrook Swamp, Rutland	95							95	High	Low	N.R.	Low	Low	Low	Mod.
N-10	Bartlett Swamp, Leominster	80							80	Mod.	Mod.	N.R.	Low	Low	Low	Mod.

TABLE 5.16 - cont. WETLAND EVALUATION RESULTS

Wetland Number	Location Description	Wetland Size (acres)	Wetland Types[1/] (acres) 1	2	3	4	5	6	7	Evaluation Rating for: Forest Manage-ment	Flood Control	Fish Habitat	Wetland Wildlife Habitat	Recre-ation	Unique-ness	Visual Quality
N-11	Bolton-Harvard Swamp, Bolton, Harvard	50			2			6	42	High	Low	N.R.	Mod.	Low	High	Low
N-12	Chaffin Pond Wetland, Holden	150			50	48	32	20		N.R.	High	Mod.	High	Mod.	High	High
N-13	Malden Hill Brook Wetland, Holden	179		58					121	High	Mod.	N.R.	Mod.	Low	Low	High
N-14	Pine Swamp, Boylston	80							80	High	Mod.	N.R.	Low	Low	Low	Mod.
B-1	Slocum Meadow, Shrewsbury	174							174	Mod.	High	N.R.	Mod.	Low	Low	Mod.
B-2	Hovey Pond Swamp, Grafton	144	10		3	92	10	29		N.R.	Low	Low	Mod.	Mod.	High	Mod.
B-3	Cider Mill Swamp, Grafton	238		8		4		40	186	Mod.	Mod.	N.R.	High	Low	High	High
B-4	Cedar Swamp, Uxbridge	142					21	37	84	Mod.	Low	Mod.	Mod.	Mod.	High	Mod.
B-5	Mill River Wetland, Mendon	168	55					18	95	Mod.	Low	N.R.	Mod.	Low	High	Mod.
B-6	West River Wetland, Uxbridge	150			35	20	2	40	53	Mod.	N.R.	Mod.	Mod.	Mod.	High	High
B-7	Rice City Pond Wetland, Northbridge, Uxbridge	105			50	45	10			N.R.	Low	Low	High	High	High	High
B-8	Hopedale Pond Wetland, Hopedale	138			14	68		34	22	High	Low	N.R.	High	High	High	High
T-1	Alder Meadows, Spencer	150				5			145	Mod.	Mod.	N.R.	Mod.	Low	High	Mod.
T-2	Wallis Pond Wetland, Dudley	73				40			33	High	Mod.	N.R.	Mod.	Mod.	High	Mod.
T-3	French River Wetland, Oxford	140			20		4	60	56	High	Low	Mod.	Mod.	Mod.	High	High
T-4	Robinson Pond Wetland, Oxford	140			40	40	40		20	Mod.	High	High	High	High	High	Mod.
T-5	Cedar Swamp, Monson	55							55	High	Low	N.R.	Low	Low	Low	Mod.
T-6	Stevens Swamp, Wales	75			10			35	30	High	Mod.	N.R.	Mod.	Low	Low	Mod.
T-7	Townline Swamp, Holland, Sturbridge	100							100	High	Mod.	N.R.	Low	Low	Low	Mod.
T-8	Single Swamp, Brimfield	92							92	High	Low	N.R.	Low	Low	Low	Mod.
T-9	East Brimfield Reservoir Wetland, Brimfield	654			16		99	109	430	High	N.R.	High	High	High	High	High

1/ Wetland types as classified in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service and are as follows: Type 1--Seasonally flooded flats; Type 2--Inland Fresh Meadows; Type 3--Inland shallow fresh marshes; Type 4--Inland deep fresh marshes; Type 5--Inland open fresh water; Type 6--Shrub swamps; Type 7--Wooded swamps; and Type 8--Bogs.

to the water resources of the region. Wetlands which are rated "High" for a number of categories should also appear high on a list of wetlands to be acquired by government, or protected by restrictions or conservation easements. Wetlands which are rated "Low" in most categories may not be too important from a water resources standpoint. The wetland evaluation, in effect, is one aid to establishing priorities in wetlands protection. Caution needs to be reemphasized at this point. A low rating may be due to the effects of several closely associated wetlands; lose any of the group and the rating of the others will go up. Also, even a wetland which rates "Low" for all evaluated purposes should not be considered suitable for development. Because of the severe limitations imposed by wet conditions, all wetlands can also be rated "Low" for suitability for development. Flood hazards, year-round problems with standing water, foundation problems, and septic system failures are among the problems to be faced by those owning developed property located on former wetlands.

Public and quasi-public ownership and the zoning of privately owned wetlands are important facets of the wetlands picture in the region. Publicly and quasi-publicly owned wetlands are usually more secure from encroachment and development than privately owned areas. Many towns in the region have acquired wetlands as conservation areas. In other instances, state forests, parks, and wildlife areas encompass wetlands. Zoning bylaws can also be a major determinant of the future of a wetland. A wetland area zoned for industrial development is in much more danger than an area zoned as flood plain land.

Public ownership information has been obtained for all the wetlands of the region (Table 5.17). Public ownership and zoning have also been obtained for the 59 wetlands evaluated for various purposes. Wetland ownership and zoning data is presented in Table 5.18.

Some interesting conclusions can be drawn from the ownership and zoning data. Public or quasi-public ownership of the evaluated wetlands is over twice as high as for all wetlands. Included in the evaluated wetlands are the U.S. Fish and Wildlife Service's Great Meadows National Wildlife Refuge along the Sudbury and Concord Rivers, the Oxbow National Wildlife Refuge along the Nashua River, and Massachusetts Division of Fisheries and Wildlife's Pantry Brook Wildlife Management Area along the Sudbury River. Also, the U.S. Corps of Engineers' East Brimfield Reservoir constitutes over 90 percent of the public or quasi-public ownership within the evaluated wetlands of the Thames Study Area. In general the federal and state public agencies and the municipalities and quasi-public groups have concentrated their acquisition in the evaluated wetlands which are the largest and better known wetland areas of the region.

TABLE 5.17 OWNERSHIP, RESTRICTIONS,1/ AND PROTECTIVE ZONING2/ OF INLAND WETLANDS

Study Area	Total Inland Wetlands (acres)	Public & Quasi-Public Ownership (acres)	Public & Quasi-Public Ownership (%) 5/	Inland Wetland Restrictions 3/ (acres)	Inland Wetland Restrictions 3/ (%) 5/	Protective Zoning 4/ (acres)	Protective Zoning 4/ (%) 5/	Total of Ownership, Restrictions and Zoning (acres)	Total of Ownership, Restrictions and Zoning (%) 5/
Merrimack	15,231	766	5.0	--	--	4,490	29.5	5,256	34.5
SuAsCo	27,216	5,160	19.0	691	2.5	9,040	33.2	14,891	54.7
Nashua	19,022	3,583	18.8	--	--	3,480	18.3	7,063	54.7
Blackstone	10,758	908	8.4	--	--	2,520	23.4	3,428	31.9
Thames	9,792	1,152	11.8	--	--	1,440	14.7	2,592	26.5
Region Totals	82,019	11,569	14.1	691	0.8	20,970	25.6	33,230	40.5

1/ Mass. G.L. Ch. 131, Sec. 40A.

2/ Municipal flood plain conservancy, watershed protection or similar zoning which restricts development activity in wetlands.

3/ Publicly or quasi-publicly owned wetlands have been subtracted from these figures.

4/ Publicly or quasi-publicly owned and inland wetland restriction totals have been subtracted from these figures.

5/ Percent of total area of subregion inland wetlands.

TABLE 5.18 EVALUATED WETLANDS SUMMARY

Study Area	Wetlands	Total Area (ac.)	Percent of Subregion's Wetlands	Area Public or Quasi-Public Owned (ac.)	(%)	Area Protectively Zoned (ac.)	(%)	Total Owned or Zoned (ac.)	(%)
Merrimack	17	3,442	22.6	376	10.9	1,731	50.3	2,107	61.2
SuAsCo	11	8,236	30.3	3,701	44.9	717	8.7	4,418	53.6
Nashua	14	2,387	12.5	806	33.8	506	21.2	1,312	55.0
Blackstone	8	1,259	11.7	167	13.3	161	12.8	328	26.1
Thames	9	1,479	15.1	699	47.3	58	3.9	757	51.2
Totals	59	16,803	20.5	5,749	34.2	3,173	18.8	8,922	53.1

5.6 WATER SUPPLY

Communities in the Central Region meet their municipal water supply needs from ground water sources or surface water supplies. In addition, seven municipalities purchase water from the Metropolitan District Commission which supplies Boston and neighboring suburbs in the Coastal Region. Many communities of the region rely to some degree on private individual supplies, wells, to meet total community water needs. There are 12 towns which have no municipal water supply and, therefore, rely entirely on private individual supplies (see Table 5.19).

SCS PHOTO

TABLE 5.19 EXISTING MUNICIPAL WATER SUPPLY

Municipality	Ground Water	Surface Water	Safe Yield (MGD)	
Merrimack Study Area				
Amesbury	X	X	1.5	
Andover	X	X	2.4	
Burlington	X	X	7.7	
Chelmsford	X	-	8.3	
Dracut	X	-	3.2	
Dunstable	X	-	-	
Haverhill	-	X	8.7	
Littleton	X	-	1.6	
Lowell	-	X	10.5	
Lawrence	-	X	14.0	
Merrimac	X	-	0.5	
Methuen	-	X	7.0	
Salisbury	X	-	3.2	
Tewksbury	X	-	3.1	
Tyngsborough	-	-	-	1/
Westford	X	-	4.8	
W. Newbury	X	-	-	2/
Nashua Study Area				
Ashby	-	-	-	1/
Ayer	X	-	1.5	
Boylston	X	-	1.0	
Clinton	-	-	-	3/
Fitchburg	-	X	12.2	
Groton	X	-	0.8	
Harvard	X	-	0.06	
Holden	X	X	2.1	
Lancaster	X	-	1.0	
Leominster	X	X	7.6	4/
Lunenburg	X	-	0.8	
Pepperell	X	-	2.1	
Princeton	-	-	-	1/
Shirley	X	X	1.2	
Sterling	X	-	0.5	
Townsend	X	-	0.5	
West Boylston	X	-	2.0	
Westminster	X	X	2.0	
Blackstone Study Area				
Auburn	X	X	2.7	5/
Blackstone	X	-	0.9	
Douglas	X	-	0.5	
Grafton	X	-	2.3	
Hopedale	X	-	0.5	
Mendon	X	X	0.03	6/
Millbury	X	-	3.8	
Millville	-	-	-	1/
Northbridge	X	-	5.6	
Sutton	X	-	0.4	
Upton	X	-	0.4	
Uxbridge	X	-	2.8	
Worcester	X	X	32.5	4/
Thames Study Area				
Brimfield	-	-	-	1/
Charlton	-	-	-	1/
Dudley	X	-	3.8	
Holland	-	-	-	1/
Leicester	X	X	1.5	
Oxford	X	-	2.4	
Southbridge	-	X	2.9	
Sturbridge	X	-	2.0	
Wales	-	-	-	1/
Webster	X	-	3.5	
SuAsCo Study Area				
Acton	X	-	3.2	
Ashland	X	-	2.0	
Bedford	X	-	1.8	
Berlin	-	-	-	1/
Billerica	X	X	7.0	
Bolton	-	-	-	1/
Boxborough	-	-	-	1/
Carlisle	-	-	-	1/
Concord	X	X	5.0	
Framingham	X	X	2.3	4/
Hopkinton	X	-	0.6	
Hudson	X	X	2.3	
Marlborough	-	X	2.0	4/
Maynard	X	X	1.0	
Northborough	X	-	1.1	4/
Shrewsbury	X	-	4.2	
Southborough	-	X	0.4	3/
Stow	X	-	0.8	
Sudbury	X	-	3.1	
Wayland	X	-	5.6	
Westborough	X	X	2.6	

1/ Private individual supplies only. 2/ All water from Groveland. 3/ Supplied entirely by MDC. 4/ Additional supplied by MDC. 5/ Partially supplied from Worcester. 6/ Private company.

5.7 IRRIGATION

Because the region has a well distributed rainfall of about 44 inches each year little irrigating is done. Areas being irrigated are generally high value nursery stock and some intensive produce operations. Few field crops require irrigation for successful production.

A total of only 800 acre-feet of water was used for irrigation in the Central Region in 1974. This is an average of less than .7 acre-foot per acre on the 1,200 acres irrigated in the region.

On the whole, irrigation is not a problem area. The ongoing program of the Soil Conservation Service is assisting growers to install irrigation systems, and other water management features. As a result, the topic of irrigation will not receive further consideration in this report.

5.8 DRAINAGE

Drainage systems have been installed on more than 430 acres of farmland in Worcester County. Little has been done elsewhere in the region. A study by Soil Conservation Service field office personnel indicates there are approximately 1,400 acres of additional farmland which could be significantly improved by drainage. Needs by Subareas are: Nashua, 500 acres; Blackstone, 400 acres; Thames, 300 acres; SuAsCo, 200 acres.

Drainage systems referred to are intended to improve production and reduce operating costs on existing farmland. Most of the systems installed in recent years have been underground drainage. Within the region, drainage of agricultural land is considered a minor problem. The Soil Conservation Service is assisting farmers to install needed drainage systems. The Agricultural Stabilization and Conservation Service (ASCS) formerly provided cost sharing funds for drainage systems. For 1978, ASCS restricts cost sharing funds for drainage systems to just those systems which are used to control saline and/or polluted waters. It is expected that few if any proposed systems in Massachusetts will qualify for ASCS cost sharing funds. In addition, assistance from SCS and ASCS is limited to lands not in Wetland Types 3 to 20 as defined in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. Therefore, drainage will not be discussed further in this report.

5.9 WATER QUALITY

According to the Massachusetts Division of Water Pollution Control, almost all of the major rivers in the region are effected by pollution to some degree. The Nashua River and the Blackstone River were infamous for their poor water quality.

Statements about existing poor water quality in the region are subject to revision as each new wastewater treatment facility comes on line. So much has happened in the last 10 years--new secondary treatment plants, (some with advanced treatment), industrial wastewater treatment, (either tie-ups with municipal plants or treatment by the industry itself), and elimination of combined sewer problems.

Major planning efforts have brought about this change. In addition to the Massachusetts Division of Water Pollution Control ongoing programs and the efforts of communities and industries, three noteworthy programs should be mentioned: The Merrimack Wastewater Study, a coordinated effort led by the U.S. Army Corps of Engineers was completed in 1971; the Nashua River Program, a demonstration project by an intergovernmental team comprised of New England Regional Commission, New England Interstate Water Pollution Control Commission, New England River Basins Commission, Environmental Protection Agency, Massachusetts Division of Water Pollution Control, and New Hampshire Division of Water Pollution; and the Plan for the Nashua River Watershed and other efforts of the Nashua River Watershed Association.

At this time for much of the region, it is not known how much must be done beyond the levels of treatment presently being installed to meet the 1977 water quality requirements or the 1983 goals of PL 92-500, (the Federal Water Pollution Control Act Amendments of 1972). The 208 studies, discussed later, should be helpful with this question.

The Massachusetts Division of Water Pollution Control has established water quality standards for waters of the state[11/] (see Figure 5.12) and these are in the process of being revised. For purposes of this report, streams were rated using the following classification.

-Fresh Water-

Class A - Waters designated for use as public water supply in accordance with Chapter 111 of the General Laws. Character uniformly excellent.

Class B - Suitable for bathing and recreational purposes including water contact sports. Acceptable for public water supply with treatment and disinfection. Suitable for certain agricultural and industrial uses; excellent fish and wildlife habitat; excellent aesthetic value.

Class B1- The use and criteria for Class B1 shall be the same as for Class B with the exception of the dissolved oxygen criteria, which is lower than Class B.

Class C - Suitable for recreational boating and secondary water contact recreation; habitat for wildlife and common food and game fishes indigenous to the region; certain agricultural and

LEGEND

- MAJOR WATERSHED BOUNDARY
- STATE BOUNDARY
- TOWN BOUNDARY
- MAJOR STREAMS & RIVERS
- PRESENT STREAM CLASSIFICATION
- PROPOSED STREAM CLASSIFICATION

Note: Proposed classification as of June 1977

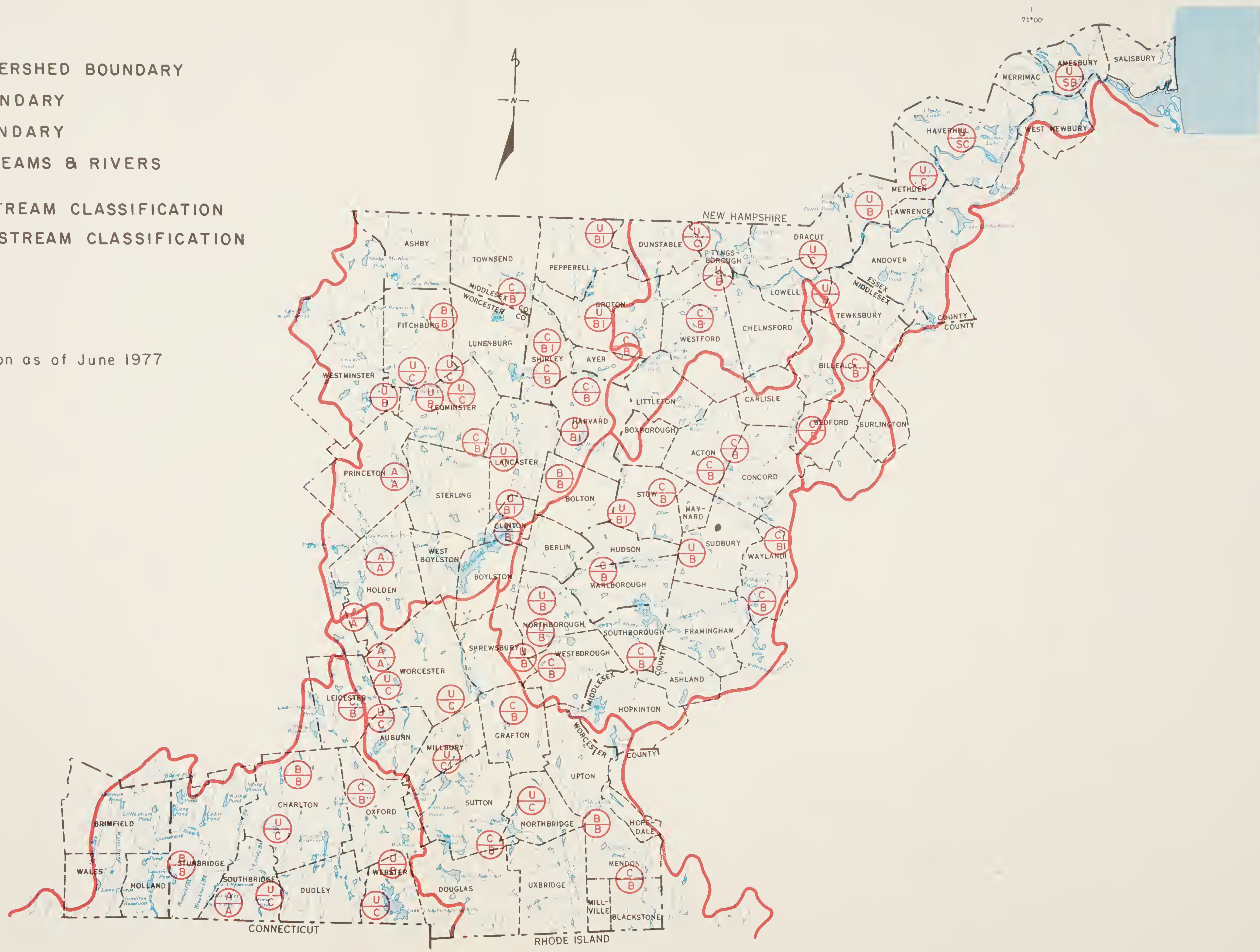


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FIGURE 5.12

WATER QUALITY STANDARDS
CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

industrial uses; under some conditions acceptable for public water supply with treatment and disinfection. Good aesthetic value.

Class C1- The use and criteria for Class C1 shall be the same as for Class C with the exception of the dissolved oxygen criteria, which is lower than Class C.

Class U[12/] - Unsatisfactory river conditions not capable of meeting "C" standards.

-Salt Water-

Class SA- Waters of the highest quality. Suitable for any use including bathing or other water contact activities. Suitable for approved shellfish areas. Highest aesthetic value and excellent fish and wildlife habitat.

Class SB- Waters suitable for bathing and recreational purposes, water contact sports, and industrial cooling. Good aesthetic values, excellent fish habitat. Suitable for certain shell fisheries (restricted shellfish areas).

Class SC- Suitable for aesthetic enjoyment, recreational boating, as a habitat for wildlife and common food and game fish indigenous to the region, and for certain industrial uses.

Sources of water pollution are normally placed into two major categories: point, or nonpoint sources.

Point sources are those where a large quantity of pollutants are discharged into a stream from a discrete, readily identifiable source. The most common examples of point sources include discharges from wastewater treatment plants and industrial plants.

Nonpoint sources are more difficult to isolate. They usually involve relatively small quantities of pollutants which are discharged over relatively large areas. Examples of nonpoint sources include urban runoff, such as salt runoff and litter from streets, animal wastes from agricultural enterprises, sediment from accelerated erosion problem areas, fertilizer and pesticide runoff from agricultural use, effluent from inadequate septic systems, and leachate from poorly situated or managed landfills or dumps. Pesticide use is regulated by the Pesticides Board, Massachusetts Department of Environmental Quality Engineering.

Merrimack River -- The Merrimack River is below its "C" classification when it enters Massachusetts from New Hampshire due to discharges in New Hampshire, and from the Nashua River which joins the Merrimack a

few miles upstream of the state line. Within Massachusetts the discharges at Lowell, Lawrence, and Haverhill, which are greatly in excess of the pollution loading in the river at the state line, ensure that the Merrimack remains below its classification for its entire length in Massachusetts. Over 100 million dollars has been spent for improvements in wastewater treatment facilities by the Massachusetts communities of the study area. In addition, the industrial sector is also heavily involved in pollutant abatement.

Nashua River -- The Nashua River had been identified as one of the most grossly polluted streams in New England. The water quality problems originate in the Fitchburg-Leominster area at the headwaters of the North Nashua River. These poor quality conditions continue to the confluence with the South Nashua River in Lancaster, and further to the confluence with the Merrimack River in Nashua, New Hampshire. Prior to the water quality sampling by the Massachusetts Division of Water Pollution Control in the summer of 1977, most major stream reaches were below water quality stream standards.

Major improvements have recently been made in the watershed due to the recently completed wastewater treatment facilities, some of which supply advanced treatment in excess of secondary treatment. However, until all of the planned facilities are on line and operating to design efficiencies, problems will persist.

SuAsCo River -- The SuAsCo consists of the Concord River, and its two principal tributaries, the Assabet and Sudbury Rivers. All three rivers do not meet presently assigned water quality standards.

In the Assabet River the spacing of the six municipal secondary wastewater treatment plants is such that the river never gets a chance to recover before it receives an additional discharge of pollutants. Higher degrees of treatment will be needed before the Assabet will meet its assigned water quality standards.

The Sudbury and Concord Rivers do not have as serious a point source problem as the Assabet, but the sluggish flow of the Sudbury and Concord Rivers is not conducive to quick assimilation of pollutants. In addition, bordering meadowlands, and wetlands contribute materials which place an additional oxygen demand in these rivers.

Blackstone River -- The Blackstone River has long been one of the Commonwealth's most polluted rivers. This situation has developed because of the large population and many industries i.e., city of Worcester and neighboring towns, located in the extreme upstream portion of the watershed.

Downstream of Worcester, domestic and industrial discharges add sufficient pollutants so that the river is unable to recover, and remains polluted to the Rhode Island line and below.

The Upper Blackstone Water Pollution Abatement District has recently constructed a new wastewater treatment facility, which Worcester and Auburn use. The towns of Leicester, Paxton, Rutland, West Boylston, Boylston, and Shrewsbury are in the district and may in the future, use this facility. Downstream, numerous towns have installed secondary treatment facilities and industries have installed treatment facilities also. Even with the large expenditure in treatment facilities, water quality of the Blackstone River is still below the state stream standards.

French and Quinebaug Rivers (Thames River) -- The French and Quinebaug Rivers are tributaries of the Thames River which begins at the confluence of the French and Quinebaug in Connecticut. In the Massachusetts portion of this basin, all major point sources of pollution receive some degree of treatment. All the municipal discharges receive secondary treatment. However, analyses by the Massachusetts Division of Water Pollution Control indicate that advanced treatment will probably be necessary to meet stream water quality classifications on Cady Brook from Charlton City to the confluence with the Quinebaug River, on the Quinebaug River below the Southbridge wastewater treatment plant to the state line, and on the French River downstream of the Leicester treatment plant (particularly in Dudley and Webster).

Section 208 of Public Law 92-500, the Water Pollution Control Act, Amendments of 1972, authorized the preparation of Water Quality Management Plans for designated areas of the country. In the Central Region, most of the towns are within a designated "Areawide Waste Treatment Management Area." See Figure 5.13 for the location of these areas.

Major objectives of most of these "208" studies will be to assess the effectiveness of the installed or planned treatment of point pollution sources and the evaluation of the magnitude and seriousness of the nonpoint problem. Tentative solutions to water quality problems will also be formulated. Studies in other parts of the United States have shown that nonpoint sources may produce half of the pollution observed. The "208" studies will attempt to determine how true this is for the Central Region.

Individual subsurface sewage disposal systems are relied on exclusively in many areas. Even in towns with some municipal sewer service, residents in outlying areas must make use of individual septic tank-leach field systems.

In most cases, an adequately designed individual disposal system is able to treat and dispose of domestic sewage with little adverse effect on the ground water. Unfortunately, many of the older systems in the region are inadequately designed and fail to remove significant amounts of nutrients such as phosphates and nitrates. An additional problem can be the adequate disposal of sludge from septic tank cleanouts.

In addition, soil conditions in much of the area are unsuitable for septic tank systems. Table 5.20 indicates results extracted from detailed soil surveys in 41 of the region towns. Limitations are due to seasonally high water table, bedrock or hardpan, and low soil permeability, these being the most common limitations on the use of individual disposal systems. A large percentage of the developable land in these towns has "severe" limitations for onsite septic tank disposal systems.

Agriculture-related pollution can result from two main sources: animal wastes, and runoff containing residues of fertilizer, pesticides, and herbicides. In the Central Region cattle, hogs, and chickens represent the largest potential source of animal waste pollution. Unless properly managed, animal wastes present a water quality hazard. In the Central Region animal waste is not a dominant pollution source because of the size of farms in the area and their location in relation to watercourses. Heavy use of commercial fertilizer is another agriculture-related nonpoint source of pollution. Fertilizer which is not utilized by crops can become a potential hazard if washed into waterways, ponds, or lakes. The high cost of fertilizer and the relatively low-value crops tend to minimize fertilizer as a significant pollution source.

Forest management activities can also cause nonpoint pollution problems. This is true where such activities as recreation, timber management, grazing, road and trail construction, and timber harvesting may occur. Certain water quality parameters, including water temperature, turbidity, total dissolved solids, nitrate-nitrogen, and fecal coliforms, may all be affected by the manner in which the watershed is managed. The severity is dependent on the particular management activities and the percentage of the watershed affected by the activities. Through proper planning, the effects of land management on water quality can be minimized.

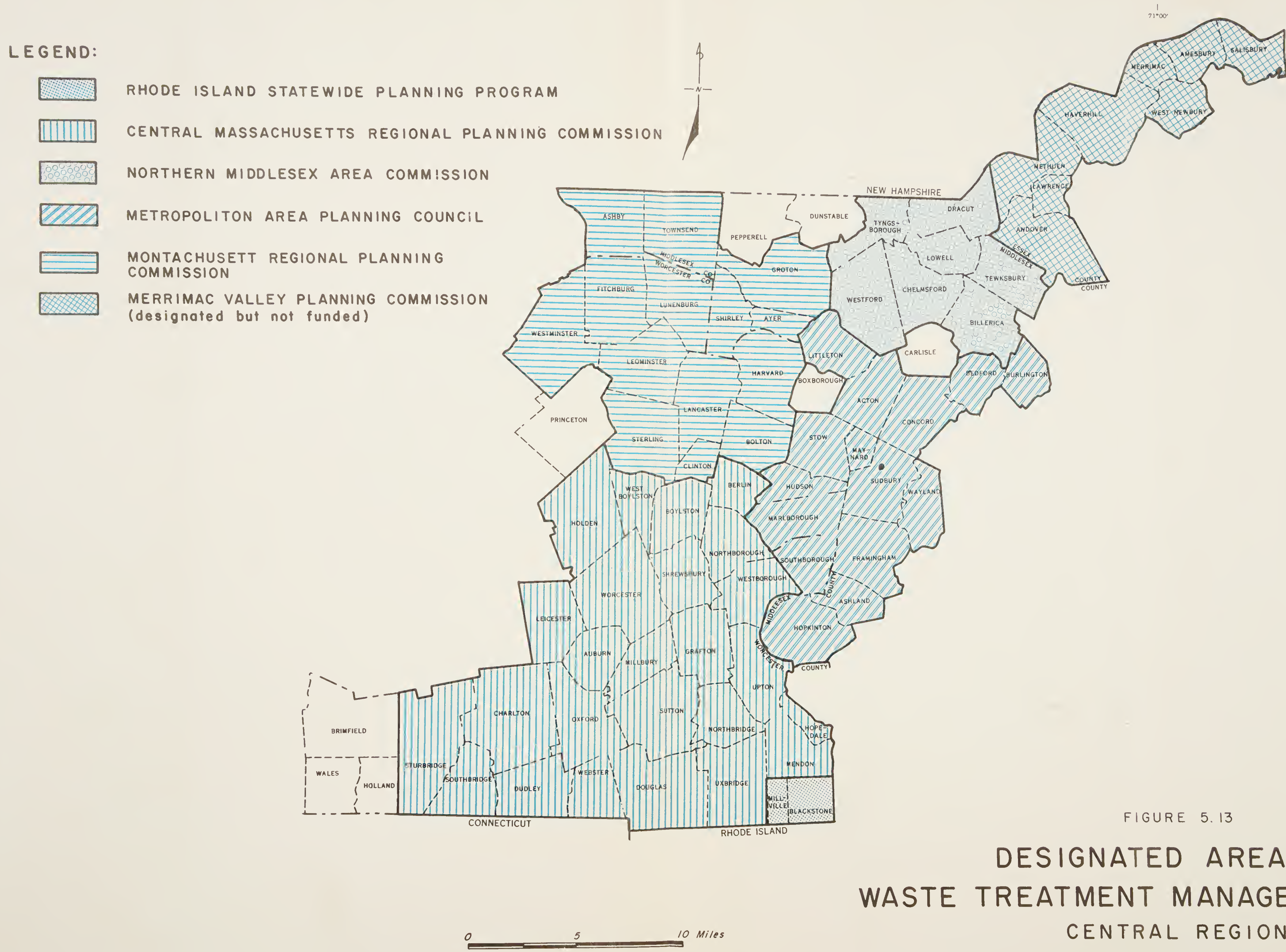

FIGURE 5.13

DESIGNATED AREAWIDE WASTE TREATMENT MANAGEMENT AREAS

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.20 LIMITATIONS FOR ONSITE SEPTIC TANK DISPOSAL SYSTEMS (from Town Soil Reports)

City/Town	Area Mapped	Excluded Areas	Water	Unclassified	Limitations for Septic Tanks: Slight	Moderate	Severe	Percent of Mapped Area with Severe Limitation
	- - - - - - - - - -	- - - - - - - - - -	- - - -	- - - Acres - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -	
Merrimack River Basin								
Amesbury	8,850	0	832	271	1,110	436	6,201	80.0
Andover	20,474	7,525	669	818	1,978	1,734	7,750	67.6
Burlington	7,603	0	31	437	637	110	6,388	89.5
Chelmsford	14,694	0	327	1,326	3,783	1,316	7,942	60.8
Haverhill	22,931	5,085	982	816	1,299	794	13,955	87.0
Littleton	11,098	0	615	736	1,577	619	7,551	77.5
Merrimac	5,491	0	172	205	703	539	3,872	75.7
Methuen	14,317	4,277	111	562	829	1,651	6,887	73.5
Salisbury	10,323	2,590	194	322	1,009	157	6,051	83.8
Tewksbury	13,382	0	213	933	3,537	939	7,760	63.4
Tyngsborough	11,647	0	837	436	1,363	2,429	6,582	63.4
Westford	19,840	0	654	1,090	3,404	3,145	11,547	63.8
West Newbury	9,382	935	0	31	247	169	8,000	95.0
Nashua River Basin								
Ayer	5,978	1,995	346	153	829	202	2,453	70.4
Boylston	12,633	3,968	187	172	504	443	7,359	88.6
Fitchburg	18,108	0	276	1,800	1,241	1,691	13,100	81.7
Harvard	13,829	0	387	160	754	388	12,140	91.4
Holden	23,176	0	975	572	2,586	1,671	17,372	80.3
Leominster	18,883	0	653	1,310	2,802	1,782	12,336	72.9
Pepperell	14,960	0	385	482	2,096	1,144	10,853	77.0
Princeton	22,850	4,010	208	90	814	1,846	15,882	85.6
Shirley	10,170	674	169	189	1,958	1,026	6,154	67.3
Sterling	20,267	0	816	249	2,325	1,221	15,656	81.5
Townsend	21,013	5,335	206	160	3,406	2,945	8,961	58.5
Westminster	23,745	3,848	978	525	1,173	2,390	14,831	80.6

TABLE 5.20 - cont. LIMITATIONS FOR ONSITE SEPTIC TANK DISPOSAL SYSTEMS (from Town Soil Reports)

City/Town	Area Mapped	Excluded Areas	Water	Unclassified	Limitations for Septic Tanks: Slight	Moderate	Severe	Percent of Mapped Area with Severe Limitation
	Acres							
				Blackstone River Basin				
Douglas	24,371	0	774	122	1,474	8,736	13,265	54.5
Grafton	14,925	0	410	775	1,658	2,140	9,942	72.3
Northbridge	11,494	0	597	490	1,091	1,588	7,728	74.2
				Thames River Basin				
Sturbridge	24,934	0	1,200	863	1,618	1,523	19,730	86.3
				SuAsCo River Basin				
Ashland	8,295	0	360	400	634	1,091	5,810	77.1
Bedford	8,864	0	117	1,409	416	107	6,815	92.9
Berlin	8,435	0	144	324	1,263	633	6,071	76.2
Billerica	16,618	0	351	1,087	4,023	354	10,803	71.2
Bolton	12,851	0	144	442	1,607	872	9,786	79.8
Boxborough	6,656	0	13	178	500	322	5,643	87.3
Concord	16,492	0	640	684	3,881	881	10,406	68.6
Hopkinton	16,653	0	0	688	828	2,471	12,666	79.3
Hudson	7,462	0	192	661	1,657	490	4,462	67.5
Northborough	11,981	0	183	448	2,307	1,151	7,892	69.5
Stow	10,430	0	407	127	2,207	626	7,063	71.4
Westborough	7,770	0	77	280	507	189	6,717	90.6

5.10 FISH AND WILDLIFE

5.10A Fish

Fishery resources in the Central Region include warm and cold water fish populations living in freshwater ponds, lakes, and streams, and anadromous species which spawn in fresh water but spend part of their lives at sea.

The most sought-after game fish are the cold water species such as the brook trout, the introduced brown trout, lake trout, and rainbow trout. Many ponds and over 100 streams in the Central Region are stocked with these species (see Tables 5.21 and 5.22). Artificial propagation and stocking are an attempt to meet the angling demand which grows continually while suitable habitat diminishes. Trout do not reproduce effectively in Massachusetts waters. They require cool waters with adequate levels of dissolved oxygen; a year-round condition that exists in very few streams. The heat of summer is limiting.

Warm water fishing in the region (and in the state as a whole) is not dependent upon artificial rearing and stocking. Bass, pickerel, and such panfish as white and yellow perch, bluegills, bullheads, and crappies can be caught. The populations of these panfish species could support more fishing pressure than they now receive.

Atlantic salmon and American shad are native anadromous species which are being restored to the Merrimack River. When restored, salmon and shad will constitute an outstanding fishery resource. They, and other outstanding fishery resources in the region are discussed in Section B.

TABLE 5.21 SUMMARY OF STREAMS

River Basin	Miles of Stream	Number of Streams Stocked Annually with Trout
Merrimack	305	23
Nashua	378	37
Blackstone	237	18
SuAsCo	307	18
Thames	152	12
	1,379	108

TABLE 5.22 SUMMARY OF INVENTORY OF PONDS, LAKES, AND RESERVOIRS 20 ACRES AND OVER IN SIZE 1/

Item	Unit	Merrimack	SuAsCo	Subregion Nashua	Blackstone	Thames	Region Totals
Ponds, Lakes &	No.	43	52	71	47	47	260
Reservoirs	Ac.	4,135	6,648	9,980	4,194	5,108	30,065
Cold Water	No.	3	5	10	1	4	23
Fisheries	Ac.	239	896	955	322	1,505	3,917
Warm Water	No.	40	47	61	46	43	237
Fisheries	Ac.	3,896	5,752	9,025	3,872	3,603	26,148
No Access,	No.	14	12	7	7	8	48
Private	Ac.	821	620	340	538	712	3,031
No Access, Public	No.	8	10	11	0	4	33
Water Supply	Ac.	1,314	2,113	1,225	0	261	4,913
Informal or	No.	17	18	47	36	27	145
Municipal Access	Ac.	1,371	1,496	3,447	2,618	1,830	10,762
Full Public	No.	4	12	6	4	8	34
Access	Ac.	629	2,419	4,968	1,038	2,305	11,359

1/ Major Data Source - Inventory of the Ponds, Lakes, and Reservoirs of Various Counties by James A. McCann et al., Water Resources Research Center, University of Massachusetts, Amherst, Massachusetts, 1972.

5.10B Outstanding Fishery Resources

Anadromous Fish Restoration, Merrimack River -- A concentrated cooperative effort involving the states of Massachusetts and New Hampshire, and federal and private agencies, is underway to restore Atlantic salmon and American shad to the Merrimack River. The Atlantic salmon is a particularly prized gamefish, and a run of 11,000 in the Merrimack is anticipated when restoration is accomplished.

Prior to the 19th century, the river supported great runs of salmon and shad, an abundant and unfailing source of food to the Indians and later to the early colonists. In 1789, it was not uncommon for a man to seine 60 to 100 salmon per day from the lower river.[13/] But as industry developed in New England, dams built to provide power and to allow navigation past rapids succeeded in cutting the anadromous fish off from their upstream spawning grounds and the lower river became seriously polluted. By 1859, the salmon was completely gone from the Merrimack, and only tiny remnant of the shad persisted.[13/]

An initial attempt to restore anadromous fish to the Merrimack Watershed failed and was abandoned in 1898. The present effort dates from 1966 and has accomplished much. The river is cleaner now, studies of the river have been completed, and efficient fishways are being planned for the dams at Lawrence and Lowell in Massachusetts and Amoskeag, Hooksett, and Garvin Falls in New Hampshire. In the spring of 1976, a release of 2,500 hatchery-reared Atlantic salmon smolts was made.

Nissitissit and Squannacook Rivers -- The Nissitissit and Squannacook Rivers provide excellent cold water fisheries in the Central Region. They both originate in New Hampshire and join the Nashua River, (the Nissitissit joining in Pepperell and the Squannacook in Shirley). The feeder streams of the Squannacook River are also very good trout streams.

Wachusett Reservoir -- Wachusett Reservoir (in Boylston, West Boylston, Sterling, and Clinton) offers a unique trophy fishery, principally for brown trout, rainbow trout, and lake trout. The all-time state record brown trout (19 pounds, 10 ounces) was taken from the reservoir in 1966. Fishing from the shore is the only type allowed, and a permit from the Metropolitan District Commission is required. There is good fishing for large and small-mouthed bass, in addition to trout.

Northern Pike -- Northern pike have been introduced at two locations in Worcester County and are stocked there annually. Pike were introduced 4 years ago into the Quinebaug River, East Brimfield Reservoir, and Holland Pond system and 2 years ago into the Quaboag River and South Pond in the Connecticut River Region. There has been no evidence of reproduction yet.

5.10C Wildlife

The Central Region of Massachusetts provides habitat for a variety of wildlife species, including resident species, migrants which are regular visitors, and others, such as moose, which occasionally wander in. The number of different ecological niches available for the species to fill is related to the geographic location of the region and the physiographic variation within it. Ecosystem types range from sand beaches at Salisbury to the pervasive upland forest which covers most of the region.

The greatest value of the wildlife species in the region, like those anywhere, is in their simply continuing to exist and perform their roles in the natural scheme of things. More obviously, we enjoy their existence in several ways, as Section D discusses.

The location of different species in the region is determined in large part by the use to which the land is put and by the resulting vegetative cover. Tables in Section E show acreages of various land uses and cover types in the Central Region, as well as species of plants and animals

which are found there. Trends in land use in the region emphasize the importance of efforts to retain or improve remaining wildlife habitat. To retain a varied animal population, it is important that their habitat be neither unbroken forest land nor fully developed urban land.

A number of species exist in limited numbers in the state and in the region. Their scarcity raises concern over the environmental conditions which are thought to be causing their declining numbers. Section F discusses scarce species, and outstanding wildlife areas within the region.

5.10D Value and Use of Wildlife Resources

The greatest value of wildlife resources is that, like man, each species is a part of an ecosystem. Each has its own role. Life depends on the adequate functioning of the whole, and knowledge of the interrelationships involved is still incomplete. Altering the size of wildlife populations by habitat modification or by other means may produce unpredictable consequences.

A secondary value of wildlife is for public recreation and its utility for both food and clothing. Wildlife is enjoyed in both consumptive and nonconsumptive ways.

Consumptive -- Approximately 2.4 percent of the Massachusetts population participates in hunting game species in the Commonwealth. Harvestable game species in the Central Region include white-tailed deer, black bear, snowshoe hare, cottontail rabbit, gray squirrel, opossum, raccoon, bobcat, red and gray fox, pheasant, ruffed grouse, woodcock, and waterfowl. They are all hunted in accordance with seasonal or daily bag limits. The following species may be taken at any time and in any numbers: house sparrow, chipmunk, flying squirrel, red squirrel, weasel, porcupine, striped skunk, and woodchuck. The discharge of firearms is prohibited by town ordinance in Burlington and Lowell and is restricted in 18 other towns in the Central Region.

Statewide hunter preference for various game species,[14/] in descending order of importance, with notes on habitat and numbers, are as follows:

Pheasant - Agricultural land well interspersed with brushland, swamps, and small woodlots. Stocked annually to supplement wild populations. There is excellent pheasant hunting in the Worcester County portion of the region, fair hunting in the remainder.

Deer - Forested land in various stages of succession, interspersed with swamps and open land. Deer hunting varies from fair to poor in the region.

Ducks and Geese - Coastal and inland wetlands, permanent open waters. The best opportunities for hunting migratory waterfowl in the region are found in Worcester County, where heavily used areas include the Quaboag River and marshes, the Blackstone, Nashua, and Assabet Rivers, and many beaver flowages. The Delaney and Nichols multiple purpose waterfowl impoundments also provide good waterfowl hunting opportunity.

Ruffed Grouse - Forest land in various stages of succession, well interspersed with old fields, orchards, and swamps. Hunting for ruffed grouse in the region is considered "average."

Cottontail Rabbit - Agricultural land well interspersed with brushland, swamps, and small woodlots. Fair hunting.

Woodcock - Woodland areas containing much alder and aspen and fairly clear of heavy ground cover. There is excellent woodcock hunting in the Worcester County portion of the region.

Gray Squirrel - Hardwood forests containing mature oak and hickory trees. Excellent squirrel hunting in the Worcester County portion of the region, average in the remainder. A much smaller number of Massachusetts residents engage in trapping than in hunting. Beaver, muskrat, otter, raccoon, mink, opossum, fox, skunk, weasel, bobcat, and fisher may be trapped.

Annual values of wildlife harvested in the state amount to about $3.5 million for food, and $0.5 million for fur.

Nonconsumptive -- Nonconsumptive recreational uses of wildlife resources include bird watching, nature study, and wildlife photography. The Central Region of Massachusetts provides a great variety of habitat types in which wildlife can be observed and photographed.

Some public lands are used extensively for these activities. The Great Meadows National Wildlife Refuge, with headquarters in Concord, comprises approximately 2,700 acres of marsh, impoundments, river bottomland and woodland. Migrating and wading waterfowl and other birds may be seen there. Other popular spots for bird-watching are the Bolton Flats Wildlife Management Area in Bolton, which is predominantly agricultural river bottomland, traversed by two rivers, and is attractive to a variety of songbirds, and the George Nichols Reservoir, (a PL 83-566 site) in Westborough which is noted for shorebirds, waterfowl, and Great Blue Heron nesting.

Nonconsumptive use of wildlife resources exceeds consumptive use on wildlife management areas of the Division of Fisheries and Wildlife.

5.10E Land Uses and Vegetative Cover

Wildlife populations in an area are intimately related to the land use and vegetative cover. Species have different needs for food, protective cover, and nesting or resting sites, which must be satisfied by their habitats if the animals are to survive. Wildlife resources in the Central Region include forest species, wetland species, and open land or agriculturally-related species. There are also some species which can live in urban and suburban environments. Table 5.23 gives acreages of the present land use and vegetative cover types in each of the study areas of the Central Region. Table 5.24 lists the vegetation and wildlife associated with the more important cover types in the region.

About 56 percent of the Central Region is in upland forest types. The forest wildlife habitat may be composed primarily of hardwood trees, softwood trees, or a combination of both. The forest stand, of whichever type, can vary in height, in density, and in the understory and ground cover vegetation associated. Those differences all affect the types and numbers of wildlife present.

Open land wildlife are those species which prefer open agricultural land or land which has recently been abandoned that is beginning to revert to woodland through natural plant succession. The category agricultural land includes tilled or tillable cropland, hayland, pasture, orchards, nurseries and greenhouses, and cranberry bogs. Abandoned agricultural land includes abandoned fields and orchards in some stage of plant succession in which grasses, forbs, and shrubs are still found. About 13 percent of the Central Region is in agriculture use or abandoned agriculture.

Wetlands comprise about 11 percent of the Central Region. Of the different types of wetlands, 56,300 acres of wooded swamps (Type 7),[15/] cover the largest area. Wooded swamps provide high value food and cover to woodcock, cottontail rabbit, hare, and deer and are important as nesting and feeding areas for wood and black ducks when the swamp borders open water. The other wetland types are listed below in order of decreasing total area, with notes about their importance to wildlife.

Open Fresh Water (Type 5) - May produce aquatic vegetation of high value to waterfowl; provides food and cover for muskrat, beaver, and otter and food for mink and raccoon. There are approximately 31,700 acres in the region.

Seasonally Flooded Basins or Flats (Type 1) and Inland Fresh Meadows (Type 2) - Seasonally flooded areas are utilized by waterfowl for feeding when flooded; fresh meadows are used as feeding grounds and for nesting with favorable conditions. Both types provide food for deer during summer and fall, year-round food for fox, skunk, weasel, and raccoon, and food and cover for pheasant. There are approximately 6,500 acres of Type 1 and 2 in the region.

TABLE 5.23

LAND USE AND VEGETATIVE COVER 1/

	Merrimack	Nashua	Study Area Blackstone	SuAsCo	Thames	Total	Percent of Region
	- - - - - -	- - - - - -	- - - Acres - - -	- - - - - -	- - - - - -	- - - - - -	
Urban	57,042	32,936	34,543	54,392	10,357	189,270	18
Hardwoods	40,821	66,785	55,034	49,518	56,605	268,763	25
Softwoods	9,301	27,015	3,409	7,688	6,073	53,486	5
Mixed Hardwood & Softwood	39,583	94,223	42,402	60,262	46,617	283,087	26
Agriculture	21,634	27,576	15,406	22,826	15,631	103,074	10
Abandoned Agriculture	9,486	8,539	4,416	8,888	5,774	37,103	3
Power Lines	1,212	2,336	1,835	589	815	6,787	1
Wetland Types 2/3/							
Wetland Types 1 & 2	1,684	1,159	704	2,515	414	6,476	1
Wetland Types 3 & 4	2,086	1,957	1,473	2,651	1,102	9,269	1
Open Fresh Water, Type 5 4/	4,285	10,579	4,437	6.553	5,870	31,724	3
Wetland Types 6 & 8	2,607	1,361	1,406	3,968	702	10,044	1
Wetland Type 7 5/	8,854	14,640	7,175	18,082	7,574	56,325	5
Saltwater Wetlands	2,527	-	-	-	-	2,527	-
Total Wetlands	(22,043)	(29,601)	(15,195)	(33,769)	(15,662)	(116,270)	(11)
Sand	-	29	14	15	-	58	-
Recreation	3,164	1,874	1,651	3,343	951	10,983	1
Mining or Waste Disposal	2,532	1,729	1,733	2,612	706	9,312	1
Total	206,818	292,643	175,638	243,903	159,191	1,078,193	

1/ Based primarily on information provided by W.P. MacConnell et al., Remote Sensing 20 Years of Change, Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst, 1974.

2/ Shaw, S.P. and C.G. Fredine, Wetlands of the United States, Circular 39, Fish and Wildlife Service, U.S. Department of the Interior, U.S. Government Printing Office, Washington, D.C., 1971.

3/ The categories presented here are:

Type 1 - Seasonally flooded basins or flats
Type 2 - Inland fresh meadows
Type 3 - Inland shallow fresh marshes
Type 4 - Inland deep fresh marshes
Type 5 - Inland fresh open water
Type 6 - Shrub swamps
Type 7 - Wooded swamps
Type 8 - Bogs

4/ Acreages derived by subtracting river areas from MacConnell's figures for open water.

5/ Wooded swamps could not be distinguished in MacConnell's analysis of aerial photography. These figures were derived by measuring areas marked by the swamp symbol on topographic maps in areas designated as forest by MacConnell.

TABLE 5.24 LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Acres	Percent of Land in Region	Vegetation Associated with Cover Type Trees/Woody Plants	Understory Plants/Nonwoody Plants	Wildlife Associated with Cover Type: Mammals	Birds	Reptiles, Amphibians
Hardwood	268,763	25	northern red oak white oak shagbark hickory red maple scarlet oak American basswood sugar maple white ash white birch American beech black locust quaking aspen black cherry American elm yellow birch	witch hazel arrowwood hobblebush wild raisin sarsaparilla partridgeberry	eastern chipmunk eastern cottontail raccoon striped skunk opossum whitetail deer white-footed mouse shorttail shrew hairytail mole starnose mole gray squirrel	ruffed grouse blue jay screech owl crow black-capped chickadee slate-colored junco	spring peeper eastern garter snake northern black racer eastern milk snake American toad
Softwood	53,486	5	white pine pitch pine eastern hemlock red pine in plantations	honeysuckle witch hazel mountain laurel	red squirrel gray squirrel northern flying squirrel eastern chipmunk shorttail shrew starnose mole white-footed mouse opossum whitetail deer	black-capped chickadee downy woodpecker hairy woodpecker white-breasted nuthatch blue jay slate-colored junco starling crow	
Mixed Hardwood and Softwood	283,087	27	red maple red oak white pine white ash black cherry American elm American basswood	honeysuckle silky dogwood raspberry	red squirrel northern flying squirrel gray squirrel eastern chipmunk eastern cottontail raccoon striped skunk opossum	ruffed grouse black-capped chickadee downy woodpecker hairy woodpecker blue jay slate-colored junco crow	spring peeper eastern garter snake northern black racer eastern milk snake American toad red-backed salamander
Wetland - Fresh Water	113,743	11	red maple black gum Atlantic cedar speckled alder black birch yellow birch willows	arrowwood alderberry high bush blueberry silky dogwood poison ivy jewelweed reed canarygrass reeds sedges grasses cattail	muskrat mink beaver otter little brown myotis	wood duck black duck mallard duck catbird cedar waxwing woodcock tree swallow	wood frog, bullfrog spring peeper leopard frog green frog eastern garter snake northern black racer spotted turtle eastern painted turtle wood turtle spotted salamander red-backed salamander

TABLE 5.24 - cont. LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Acres	Percent of Land in Region	Vegetation Associated with Cover Type Trees/Woody Plants	Understory Plants/Nonwoody Plants	Wildlife Associated with Cover Type: Mammals	Birds	Reptiles, Amphibians
Open Land (Agricultural Land)	103,074	10	Trees grown include domestic fruit trees, ornamental shrubs, and Christmas trees.	Crops and forage grown include silage, corn, vegetables, alfalfa and grasses.	meadow vole shorttail shrew starnose mole woodchuck whitetail deer striped skunk eastern cottontail	goldfinch meadowlark field sparrow mourning dove ring-necked pheasant red-winged blackbird cowbird starling grasshopper sparrow	eastern garter snake American toad
Open Land (Abandoned Agricultural Land)	37,103	3	silky dogwood gray dogwood pasture juniper red maple gray birch high bush blueberry low bush blueberry	goldenrod milkweed hawkweed timothy fescue	eastern cottontail red fox striped skunk woodchuck eastern chipmunk whitetail deer shorttail shrew meadow vole	goldfinch red-winged blackbird cowbird ring-necked pheasant mourning dove starling	eastern smooth green snake eastern garter snake eastern milk snake northern black racer American toad
Urban	189,270	18	ornamental trees	grasses ornamental herbs and shrubs	Norway rat house mouse gray squirrel shorttail shrew eastern mole	rock dove starling English sparrow nighthawk grackle	
Power Lines	6,787	1	Trees which do not interfere with primary land use.	grasses low shrubs	eastern cottontail	rufous-sided towhee slate-colored junco ruffed grouse	eastern garter snake northern black racer eastern milk snake American toad common newt spotted salamander
Recreation	10,983	1					
Mining or Waste Disposal	9,312	1					

Inland Shallow (Type 3) and Deep (Type 4) Marsh - Shallow fresh marsh is a very important type, used by waterfowl for nesting and feeding; deep fresh marsh is the most important inland type; it is used for feeding and, in some cases, nesting by waterfowl; both types provide food and/or cover to muskrat, mink, and a variety of other species. There are approximately 9,300 acres of Type 3 and 4 in the region.

Shrub Swamps (Type 6) and Bogs (Type 8) - Important to waterfowl when it borders permanent open water; shrub swamps provide high value food and cover to woodcock, cottontail, hare, and deer, and food and/or cover to other species. There are approximately 10,000 acres of these two types in the region.

The kinds of plants found in wetlands in the region vary widely, and depend on the depth of water, period of flooding, or stage of plant succession. Nearly all types of land, and uses of land, support or allow some wildlife species. The greater the habitat diversity, the greater the diversity of wildlife species. Edge, between different types of cover, such as field, forest, or wetland is extremely valuable to wildlife because it provides nearby food and cover.

Land uses and vegetative cover are not static. Changes occur both with and without human action and those changes can drastically alter the size and composition of wildlife populations. Natural succession gradually changes vegetative cover, moving it in stages toward the climax condition for the particular location. Abandoned agricultural fields grow up into young forests. Young forests mature and age to become old forests. Without some intervention, such as fire, timber harvest, or some sort of land clearing, natural succession effectively eliminates open land and, leads to the elimination of wildlife species which require or prefer open land. In addition, as lands become increasingly forested, diversity is reduced, and as a result numbers and variety of the wildlife species they contain is reduced. This progression toward unbroken forest is a major trend in Massachusetts today.

Working in opposition to that trend is a man-caused trend toward the development of all lands easily built upon for residential, commercial, or industrial uses. These easily built-upon lands are usually agricultural or abandoned agricultural lands. In Worcester County, agricultural and open lands dropped from 22 percent to 13 percent of the county between 1951 and 1971, while highway commercial land use increased 270 percent and 696 acres of new shopping centers were built.[16/] When such development occurs open land habitat, and essentially all wildlife habitat are eliminated.

If Massachusetts is to retain or increase the numbers, and variety of wildlife species which it now supports, efforts must be made to provide the necessary diversity, and land suitable for habitat. Preservation of farmland and more active timber harvesting programs are two important means of attaining this goal.

5.10F Outstanding Wildlife Resources

Great Meadows National Wildlife Refuge -- Established in 1944, the Great Meadows National Wildlife Refuge preserves approximately 2,700 acres along the Concord and Sudbury Rivers. The refuge provides an outstanding area for waterfowl and other water-associated birds. Its headquarters is located in Concord, and the refuge extends into six surrounding towns.

Oxbow National Wildlife Refuge -- The Oxbow covers 662 acres, of Fort Devens in Harvard. The Defense Department transferred this area to the U.S. Fish and Wildlife Service in 1974. This area, listed as W-1 of the evaluated wetlands, lies along the Nashua River and provides an outstanding area for waterfowl.

Merrimack River Estuary -- This estuary, located in the town of Salisbury and Newburyport, is a bird watcher's hot spot. Waterfowl, shorebirds, songbirds, raptors, and other birds can be seen from the popular viewing spots along the estuary. During the 1974-75 winter a Ross' Gull, an exceedingly rare visitor from Siberia, was viewed by hundreds of people from all over the northeast who came specifically to see this bird.

Wildlife Management Areas and Sanctuaries -- The Massachusetts Division of Fisheries and Wildlife maintains over 20 wildlife management areas (WMA) and other holdings in the region. Three of the larger areas are the Pantry Brook WMA in Concord and Sudbury, Squannacook WMA in Townsend, Groton and Shirley and Bolton Flats WMA in Bolton. In addition approximately 2,000 acres of the U.S. Department of the Army's Fort Devens in the towns of Ayer, Shirley and Lancaster are managed as wildlife habitat by the Massachusetts Division of Fisheries and Wildlife.

The Massachusetts Audubon Society maintains four wildlife sanctuaries in the region. The largest of these sanctuaries is Wachusett Meadow in Princeton, which is adjacent to the Massachusetts Division of Fisheries and Wildlife's Minns Wildlife Sanctuary and Wachusett Mountain State Reservation owned by the Massachusetts Division of Forests and Parks.

Species Existing in Limited Numbers -- Table 5.25 lists wildlife species which exist in limited numbers in the Central Region. One's likelihood of observing any of these species is small, but their continued existence is important.

Several of the listed species are believed to be declining in numbers. One of these, the eastern bluebird, is believed to suffer from habitat decline, from the effects of pesticides, and from competition for nesting sites. Acid rain (a consequence of air pollution) is thought to be detrimental to the reproduction of the spotted, blue spotted, and marbled male salamander, and is a factor in their decline.

TABLE 5.25 WILDLIFE SPECIES EXISTING IN LIMITED NUMBERS IN THE STATE WHICH ARE FOUND IN THE CENTRAL REGION[1/]

Species	Distribution	Estimated Numbers	Typical Habitat	Status[2/]
Mammals				
Eastern cougar	Inconclusive, unverified reports from central and western Mass.	If present, cannot be more than a few.	Isolated mature or second growth woodlands and mountainous areas.	Endangered
Eastern coyote	Berkshire, Franklin, Hampden, Hampshire, and northern Worcester counties.	Probably several hundred.	Rural wilderness	
Moose	Occasional stragglers range into northeastern, central, and western parts of the state.	None resident; regular stragglers appear almost annually.	Wilderness areas of early successional mixed stands interspersed with bogs and shallow ponds.	Peripheral
Birds				
Eastern bluebird	Transient statewide, limited breeding, especially in Conn. Valley.	Unknown	Open woods, swamps, rural roadsides, farmland, burnt-over areas.	Undetermined
Reptiles				
Blanding's turtle	Northern Middlesex County and Haverhill (Essex County).	Unknown	Shallow, weedy ponds, slow moving streams.	Undetermined
Eastern box turtles	Statewide, except mountainous regions.	Unknown	Fields, woods, open woodlands, usually near water.	Undetermined
Black rat snake	South-central Mass., east to Webster, west to Westfield, north to Sunderland.	Unknown	Wooded uplands, hillsides, forest edges.	Undetermined
Blue spotted salamander	Recorded from various areas of Middlesex County and a few Essex County towns.	Unknown	Lives underground in moist woodlands.	Threatened
Marbled salamander	Principally throughout Worcester County and east (localized populations), with remnant colonies in Middlesex, Bristol, and Plymouth Counties.	Unknown	Woodlands	Threatened
Spotted salamander	Localized populations statewide, except offshore islands.	Unknown	Lives underground in moist woodlands.	Threatened
Four-toed salamander	Scattered from Conn. Valley eastward to Cape Cod.	Unknown	Swamps, sphagnum bogs, acidic meadows.	Undetermined

1/ Mugford, P.S., An Inventory of Massachusetts Fish and Wildlife (Vertebrate) Resources. Massachusetts Division of Fisheries and Wildlife, Boston, 1975.

2/ Rare - Not immediately in peril and possibly stable at present, but existing in such low numbers or with such a restricted distribution that the entire species population could be seriously jeopardized by catastrophic events occurring within its range.

Endangered - In immediate danger of extinction or extirpation from the state due to critically low or drastically declining populations brought about by habitat modification, overexploitation, pollution, diseases, or other factors.

Status Undetermined - Not in immediate danger of extinction or extirpation but showing signs of decline and causing justifiable concerns or being little known or apparently uncommon and possibly could be jeopardized by inadvertent actions. More information required to properly evaluate status.

Peripheral - Reaches the limit of its usual range outside Massachusetts. Occasional individuals or stragglers may be found but no breeding populations within the state.

Threatened - Likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range.

5.11 RECREATION

The analysis of recreation supply, demand, needs, and alternatives has been limited to those outdoor recreation activities which are water-related or which are normally assumed to be enhanced or complimented by adjacent water bodies. These activities include swimming, camping, picnicking, canoeing and sailing, and hiking. The primary data source for recreation has been the 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) prepared by the Massachusetts Department of Environmental Management. Available recreation activities are shown in Table 5.26.

TABLE 5.26 SUPPLY OF SELECTED RECREATION ACTIVITIES

Activity	Supply (1000 Activity Days)
Swimming	10,950
Camping	363
Picnicking	1,061
Canoeing-Sailing	1,943
Hiking	860

The available supply of recreation resources were obtained from figures for SCORP Regions III and IV, adjusted to fit the Central Region. The SCORP Regions are shown on Figure 5.14. The supply figures give a good indication of the extent of outdoor recreation available in the Central Region.

In addition to the recreation resources that can be quantified by the activity days that they provide, the Central Region boasts a number of "landscape and natural areas" which provide a large quantity of passive recreation and enjoyment. These areas which have been identified in the 1974 Massachusetts Landscape and Natural Areas Survey include natural areas with unique scenic, historic or scientific significance. There is a total of 55 of these natural areas located in the region. Of these, 32 sites are owned by governments, private conservation organizations, or institutions. Twenty-three of the natural areas are wholly or partially owned by private individuals. Ownership of the natural areas is quite important in determining public access to enjoy the resource. The vulnerability of the area to disruption, and even possible loss through development is also dependent upon ownership and owner attitude. In some cases, the publicly owned areas are in jeopardy while some privately owned areas are safe and zealously protected by the owner.

The region's historical and cultural attractions include the Minuteman National Historic Park in Concord and Old Sturbridge Village which duplicates an early 19th century rural New England village. Numerous historic inns, homes, mills, and other buildings are a reminder of the vivid

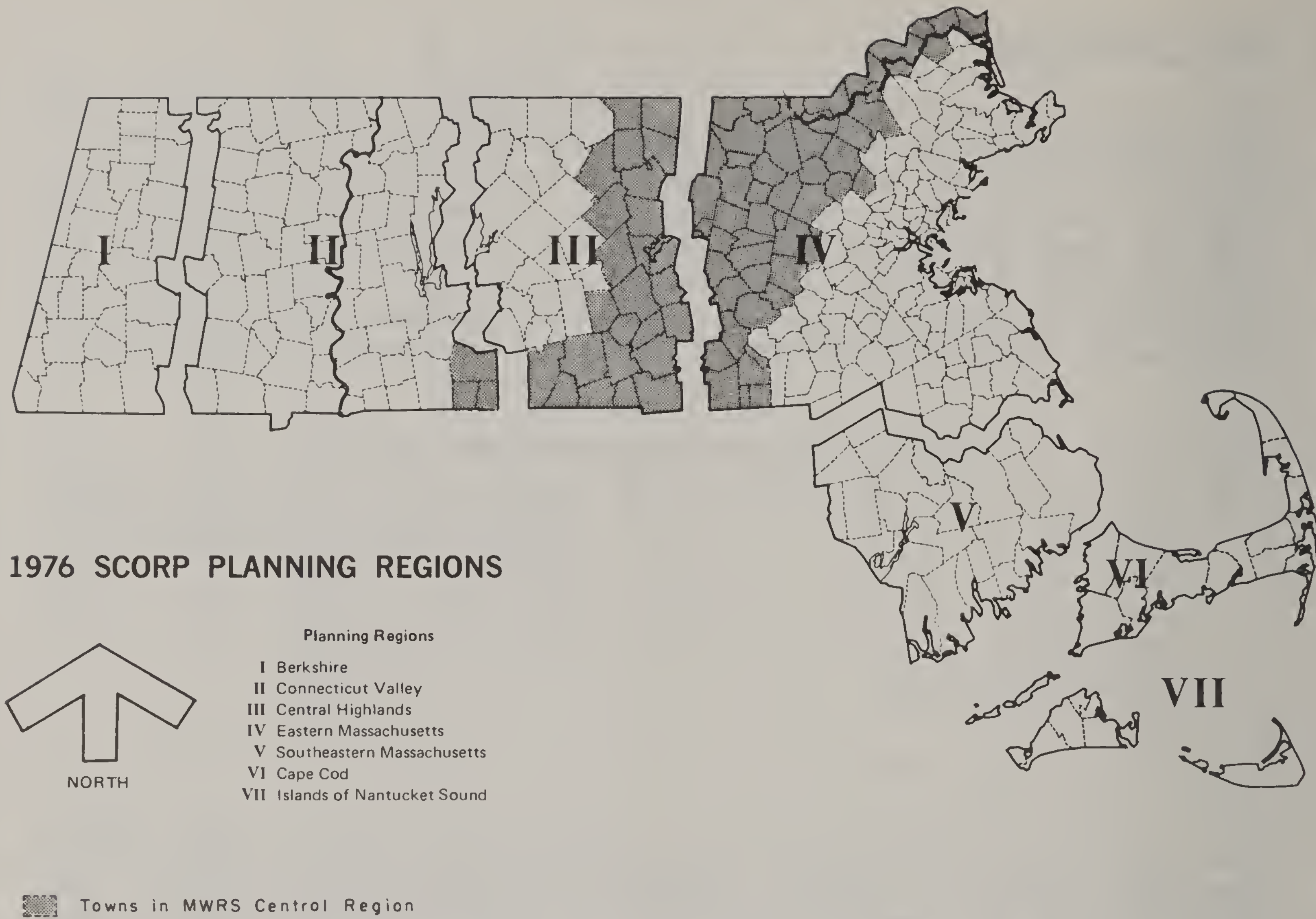

FIGURE 5.14

SCS PHOTO

history of the region. The region has approximately 70 properties listed in the National Register of Historic Places, of these, 13 have been designated as National Historic Landmarks. The many museums, colleges and universities add to the cultural base of the area.

The region's rivers represent a great, largely undeveloped recreational resource. There are over 1,380 miles of main rivers and tributaries in the region. Seven river reaches in the Central Region are identified in the SCORP report as providing excellent potential for development as canoe trails. The Nashua River Watershed Association sponsors an annual canoe race on the Nashua every spring and in addition has published a canoe guide for the Nashua River. Table 5.27 indicates the portions of river identified for this purpose.

TABLE 5.27 POTENTIAL CANOE TRAILS

River	Section of River
Stillwater River	Leominster to Wachusett Reservoir
Nashua River	Clinton to New Hampshire
Stony Brook	Littleton to Chelmsford
Merrimack River	Tyngsborough to Newburyport
Concord River (and Sudbury River)	Framingham to Lowell
Shawsheen River	Bedford to North Andover
Quinsigamond River (and Blackstone River)	Flint Pond, Grafton to Uxbridge

The SCORP report also identifies several rivers which should be considered for protection under the Scenic and Recreational Rivers Act, Chapter 21, Section 17B of the General Laws. These rivers are included in Table 5.28.

TABLE 5.28 POTENTIAL SCENIC AND RECREATIONAL RIVERS

River	Section of River
Nashua River	Leominster to New Hampshire
Nissitisset River	New Hampshire line to Nashua River
Squannacook River	Source to mouth
Quinapoxet River	Source to Wachusett Reservoir
Assabet River	Tyler Dam to Hudson Dam
Sudbury River	Hopkinton town line to Ashland Dam
Concord River	Confluence of Sudbury and Assabet Rivers to mouth
Shawsheen River	Billerica and Tewksbury
West River (Blackstone River)	West Upton Dam to mouth
Quinebaug River	East Brimfield Dam to Connecticut state line

There are 260 ponds and lakes, all measuring at least 20 acres in size, located within the region. These provide more than 30,000 acres of surface water. Surface water bodies are used for municipal and industrial water supply, fishing, fish and wildlife habitat, swimming, and boating, as well as providing visual contrast and aesthetic pleasure.

Access to freshwater bodies in the region is usually a function of their ownership and use. Reservoirs used for municipal water supply normally have restrictions upon public access and use. Swimming or wading is prohibited by state statute in all but supplementary, emergency supplies. Fishing and boating is also restricted, although there may be scattered instances of tightly-controlled reservoir fishing. Public access to the ponds, lakes, and reservoirs of the region is detailed in Appendix C prepared for the study by the Massachusetts Division of Water Resources.

MASS. DEPT. OF ENVIRONMENTAL MGT. PHOTO

The Public Access Board, under the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles, uses a small portion of the income it receives from the state General Fund to acquire public access to great ponds and other waters and for access to snowmobiling, hiking, and skiing trails. The Board develops public sites by constructing launching ramps, canoe or small boat landings, parking areas, and approach roads.

The Public Access Board will continue to develop facilities throughout the state. The Board's program has been concentrated on the larger, more popular areas so that greater numbers of people will benefit.

The Public Access Board has acquired access to the following waters in the Central Region of Massachusetts:

Water Body	Location	Area (acres)
Merrimack		
Black Rock Creek	Salisbury	tidal waters
Flint Pond	Tyngsborough	61
Lake Attitash	Merrimac	360
Mascopic Lake	Tyngsborough	290
Merrimack River	Andover	14 miles of river
Nashua		
Baddacook Pond	Groton	76
Fort Pond	Lancaster	33
Knopps Pond	Groton	204
Squannacook River	Pepperell	river
Whalom Pond	Leominster	100
Blackstone		
Manchaug Pond	Sutton	412
Singletary Pond	Millbury	356
Wallum Lake	Douglas	256
SuAsCo		
Delaney Pond	Stow	168
Lake Chauncey	Westborough	185
Lake Quinsigamond	Shrewsbury	1051
Whitehall Reservoir	Westborough	601
Thames		
Alum Pond	Sturbridge	172
East Brimfield Reservoir	Brimfield, Sturbridge	420

The federal government provides numerous recreation opportunities throughout the region. The National Park Service is in the process of acquiring an additional 80 acres of land before 1980 to add to the 500-acre Minuteman National Historic Park in Concord, Lexington, and Lincoln. The U.S. Fish and Wildlife Service manages two refuges in the region; the Great Meadows National Wildlife Refuge along the Sudbury and Concord Rivers and the Oxbow National Wildlife Refuge along the Nashua River within the Fort Devens U.S. Military Reservation.

The state government is the largest landholder of open space and recreation acreage in Massachusetts. The Division of Forests and Parks and the Division of Fisheries and Wildlife are the state agencies who administer most of the state's recreation acreage. Over a thousand acres of PL 83-566 project land owned by Massachusetts Water Resources Commission is open to passive recreation. Table 5.29 lists major public and quasi-public recreation use areas giving their location and size.

Town conservation land, town forests, and sometimes water supply watershed lands provide recreation close to population centers.

Private lands which are open to the public for recreation are also important in the region. The Massachusetts Audubon Society controls approximately 1,100 acres of land which is managed for wildlife habitat and which also provides hiking trails and opportunities to observe and enjoy the natural beauty of the areas. Also, the Trustees of Reservations are responsible for the management of approximately 450 acres of natural areas which are used extensively for passive recreation.

Recreation planning on a regional basis has been done by the regional planning agencies and by the Massachusetts Department of Environmental Management (DEM), Office of Planning. The 1976 SCORP was produced by DEM and a representative plan for the RPA work is "Regional Recreation and Open Space and the Urban Cultural Park" by the Northern Middlesex Area Commission. In addition, watershed associations and other private groups have made important contributions in recreation planning and later implementation; for example, the Nashua River Watershed Association's Greenway Project which is establishing a greenbelt in the Nashua River flood plain in Massachusetts and New Hampshire. Other greenbelt proposals have been presented by the RPA's and others for the Merrimack River and other major rivers in the region. Establishment of greenbelts for the Merrimack, Concord, Sudbury, Assabet, Blackstone, and Quinebaug Rivers, similar to the Nashua River program, is a worthwhile proposal which could greatly increase the recreation base of the region. With the improvement in water quality projected for these major rivers, their recreation value will increase.

TABLE 5.29 MAJOR PUBLIC AND QUASI-PUBLIC AREAS WITH RECREATION USE

Agency	Site 1/	Location	Size-Acre
<u>Federal</u>			
U.S. Army Corps of Engineers	(1) West Hill Dam	Uxbridge	614 2/
	(2) East Brimfield Lake	Sturbridge, Brimfield, Holland	2,070
	(3) Westville Lake	Southbridge	578 2/
	(4) Buffumville Lake	Oxford	488
	(5) Hodges Village Dam	Oxford	873
U.S. National Park Service	Minuteman National Historic Park	Concord, Lexington, Lincoln	508
U.S. Fish & Wildlife Service	Great Meadows National Wildlife Refuge	Bedford, Billerica, Carlisle, Concord, Lincoln, Sudbury, Wayland	2,700
	Oxbow National Wildlife Refuge	Harvard	662
		Subtotal	(8,493)
<u>State</u>			
Massachusetts Division of Forests and Parks	(1) Salisbury Beach S.R.	Salisbury	520
	(2) Wachusett Mt. S.R.	Princeton, Westminster	1,696
	(3) Walden Pond County R.	Concord, Lincoln	350
	(4) Walden Pond S.P.	Concord, Lincoln	117
	(5) Ashland S.P.	Ashland	470
	(6) Cohituate S.P.	Framingham, Natick, Wayland	1,126
	(7) Hopkinton S.P.	Ashland, Hopkinton	960
	(8) Warren Manning S.P.	Billerica	40
	(9) Whitehall S.P.	Hopkinton	877
	(10) Lake Quinsigamond S.P.	Shrewsbury, Worcester	39
	(11) Purgatory County R.	Sutton	300
	(12) Wells S.P.	Sturbridge	1,081
	(13) Billerica S.F.	Billerica	335
	(14) Blanchard Road S.F.	Andover	35
	(15) Carlisle S.F.	Carlisle	58
	(16) Harold Parker S.F.	Andover, Boxford, Georgetown, Middleton, North Andover, North Reading	3,511
	(17) Lancaster S.F.	Lancaster	90
	(18) Lowell-Dracut S.F.	Lowell, Dracut	796
	(19) Marlborough S.F.	Marlborough	60
	(20) Sudbury S.F.	Hudson, Marlborough, Stow	234
	(21) Upton S.F.	Hopedale, Hopkinton, Northbridge, Upton	2,695
	(22) Ashby S.F.	Ashby	20

TABLE 5.29 - cont. MAJOR PUBLIC AND QUASI-PUBLIC AREAS WITH RECREATION USE

Agency	Site 1/	Location	Size-Acre
Massachusetts Division of Forests & Parks - cont.	(23) Douglas S.F.	Douglas	3,227
	(24) Leominster S.F.	Fitchburg, Leominster, Princeton, Sterling	2,953
	(25) Oxford S.F.	Oxford	29
	(26) Squannacook River S.F.	Townsend	299
	(27) Sutton S.F.	Sutton	624
	(28) Townsend S.F.	Townsend	3,092
	(29) Willard Brook S.F.	Ashby, Townsend, Lunenburg, Fitchburg	2,554
	(30) Westminster S.F.	Gardner, Westminster	1,406
	(31) Brimfield S.F.	Brimfield, Monson, Wales	3,289
		Subtotal	(32,883)
Massachusetts Division of Fisheries & Wildlife	(1) Ayer Game Farm	Ayer	97
	(2) Merrill Pond System	Sutton	216
	(3) Pantry Brook W.M.A.	Concord, Sudbury	401
	(4) Townsend W.M.A.	Townsend	60
	(5) Westborough W.M.A. & Field Trail Area	Westborough, Northborough	333
	(6) Cosne Pond W.M.A., West Newbury	West Newbury	243
	(7) Northborough W.M.A.	Northborough	88
	(8) Squannacook W.M.A.	Townsend, Groton, Shirley	711
	(9) Charlton W.M.A.	Charlton	287
	(10) Nissitissit River W.M.A.	Pepperell	246
	(11) North Shore W.M.A., Salisbury portion	Salisbury	97
	(12) E. Kent Swift W.M.A.	Mendon, Northbridge, Uxbridge	157
	(13) Carr Island W.S.	Salisbury	110
	(14) Minns W.S.	Princeton	137
	(15) Ram Island W.S.	Salisbury	20
	(16) Flint Pond Access	Tyngsborough	82
	(17) Knops Pond Lot Access	Groton	<1
	(18) Mascopic Lake Access	Dracut	<1
	(19) Quinapoxet River Area Access	Holden	32
	(20) Marcus Area Access	Uxbridge	28
	(21) Fort Devons W.M.A.	Ayer, Shirley, Lancaster	2,000 2/
	(22) Bolton Flats W.M.A.	Bolton	600
		Subtotal	(5,945)

TABLE 5.29 - cont. MAJOR PUBLIC AND QUASI-PUBLIC AREAS WITH RECREATION USE

Agency	Site 1/	Location	Size-Acre
Massachusetts Water Resources Comm.	(1) Delaney Flood Control Project & W.M.A.	Harvard, Bolton, Stow	581
	(2) Tyler Flood Control Project	Northborough, Marlborough	233
	(3) Ross Flood Control Project	Berlin	238
	(4) Brewer Brook Flood Control Project	Berlin	50
	(5) Nichols Flood Control Project	Westborough	520
	(6) Rawsen Hill Brook Flood Control Project	Shrewsbury	80
	(7) Hop Brook Flood Control Project	Northborough	160
	(8) Cold Harbor Flood Control Project	Northborough	206
	(9) Barefoot Brook Flood Control Project	Northborough, Marlborough	54
		Subtotal	(2,122)
Metropolitan District Commission	(1) Wachusett Reservoir Reservation	West Boylston, Sterling, Boylston, Clinton	10,809
	(2) Sudbury Reservoir Reservation	Marlborough, Southborough	3,214
		Subtotal	(54,973)
Trustees of Reservations	(1) Charles Ward Reservation	Andover	595
	(2) Old Manse	Concord	8
	(3) Redemption Rock	Princeton	<1
	(4) Tantiusques	Sturbridge	55
Massachusetts Audubon Society	(1) Waseeka W.S.	Hopkinton, Holliston	140
	(2) Lincoln Woods W.S.	Leominster	60
	(3) Wachusett Meadow W.S.	Princeton	907
	(4) Laurel Woods W.S.	Holden	16
		Subtotal	(1,781)
		Total	(65,247)

1/ Following abbreviations are used: S.R. - state reservation; S.P. - state park; S.F. - state forest; W.M.A. - wildlife management area; W.S. - wildlife sanctuary

2/ Managed by Massachusetts Division of Fisheries & Wildlife as wildlife habitat under agreement.

A major state recreation project is now underway in the Lowell area. This project is on a par with the other five major state projects, one of which is the Boston Harbor Islands project. The Lowell Heritage State Park funded at approximately $9 million is focused on the Merrimack and Concord Rivers and the interconnecting industrial canal system on which the textile industry in Lowell depended. In addition to the state's and the city of Lowell's efforts, the U.S. Congress is considering a bill to establish a Lowell National Cultural Park to be administered by the National Park Service. The report from the Lowell Historic Canal District Commission provides the background for this congressional bill. The estimated cost of this congressional plan is approximately $40 million.

Two other canal systems, both long abandoned, have been proposed for restoration for recreational purposes. They are the Middlesex Canal which went from Boston Harbor to the Merrimack River at Lowell, and the Blackstone River Canal which originated in Rhode Island and terminated in Worcester. A few of the larger water bodies in the Blackstone Watershed were impounded by the builders of the Blackstone Canal to augment summer low flows in this canal.

There are numerous opportunities for hiking in the region. Massachusetts Division of Forests and Parks have developed hiking trails in the state forests, parks, and reservations and there are extensive short distance trails which have been developed by members of the Appalachian Mountain Club and other similarly orientated groups. The 1976 SCORP mentions the mid-state trail, which runs from Douglas on the Rhode Island state line to Ashburnham which borders New Hampshire. This trail connects with the Wapack trail which continues on to Pack Monadnock Mountain in New Hampshire.

5.12 EXISTING PROGRAMS

Information on programs which effect the resources we are addressing in this study is summarized in the following tables and figures.

TABLE 5.30

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use	Municipalities	Massachusetts General Laws, Chapter 61A, Sections 1-24 - The Agricultural and Horticultural Assessment Act. The act is designed to provide economic incentives in the form of lower property taxes to encourage maintenance of productive agricultural or horticultural pursuits. The act also has the effect of preserving open space. Massachusetts is one of 32 states that provide for such assessments. This act is sometimes referred to as the "Current Use Taxation of Farmland and Horticultural Land."
	Municipalities	Massachusetts General Laws, Chapter 184, Sections 23-33 - An act to protect conservation and preservation restrictions which are held by an appropriate public authority.
	Municipalities, Mass. Division of Forests and Parks	Massachusetts General Laws, Chapter 61, Sections 1-7 - The Classification and Taxation of Forestlands (General Laws, Chapter 61) as amended. Landowners who have at least 10 contiguous acres of forestland having a value not over $400 an acre (land and timber) may apply to their local tax assessors to have their forestland classified under the law. If the state forester determines that the woodland owner qualifies, the land and timber are taxed separately. The land is assessed at not more than $10 per acre and annual taxes are paid on this basis. Also, a forest products tax of 8 percent is paid on the value of forest products harvested. A rollback applies if the land is withdrawn from the forest classification. In addition to the tax incentive program for private landowners there is a forest management program for public forest holdings.
	Soil Conservation Service, Conservation District, landowners	Conservation Operations Program - Proper land treatment is the basic concern of the Soil Conservation Service. This is the purpose of the Conservation Operations Program which provides technical assistance and advice on soil and water conservation to land users through local conservation districts. In the region, requests for assistance go to the Essex, Middlesex, Northeastern Worcester, Northwestern Worcester, Southern Worcester or Hampden Conservation Districts which determines priorities for the Conservation Operations Program. The district is an arm of state government, having five unpaid supervisors whose job it is to consult with and advise the local SCS staff in scheduling their work load. Practices applied in the Conservation Operations Program include improved agronomic practices, measures to reduce soil erosion, practices designed to help carry water safely off sloping land, drainage improvements, and comprehensive measures to improve wildlife habitat and recreational areas.
	Farmers Home Administration, landowners	Soil and Water Loans - These loans are to facilitate improvement, protection, and proper use of farmland by providing adequate financing and supervisory assistance for soil conservation; water development, conservation and use; forestation; drainage of farmland; the establishment and improvement of permanent pasture; and related measure. Loans cannot exceed $100,000.
	U.S. Agricultural Stabilization and Conservation Service, landowners	The Agricultural Conservation Program (ACP), provides cost sharing assistance to farmers and other landowners who undertake soil, water, forest and wildlife conservation practices. The cost for such practices is shared between the federal government and the landowner. Technical assistance for ACP practices is rendered by the Soil Conservation Service, the Extension Service, and the U.S. Forest Service in cooperation with the Massachusetts Division of Forests and Parks.

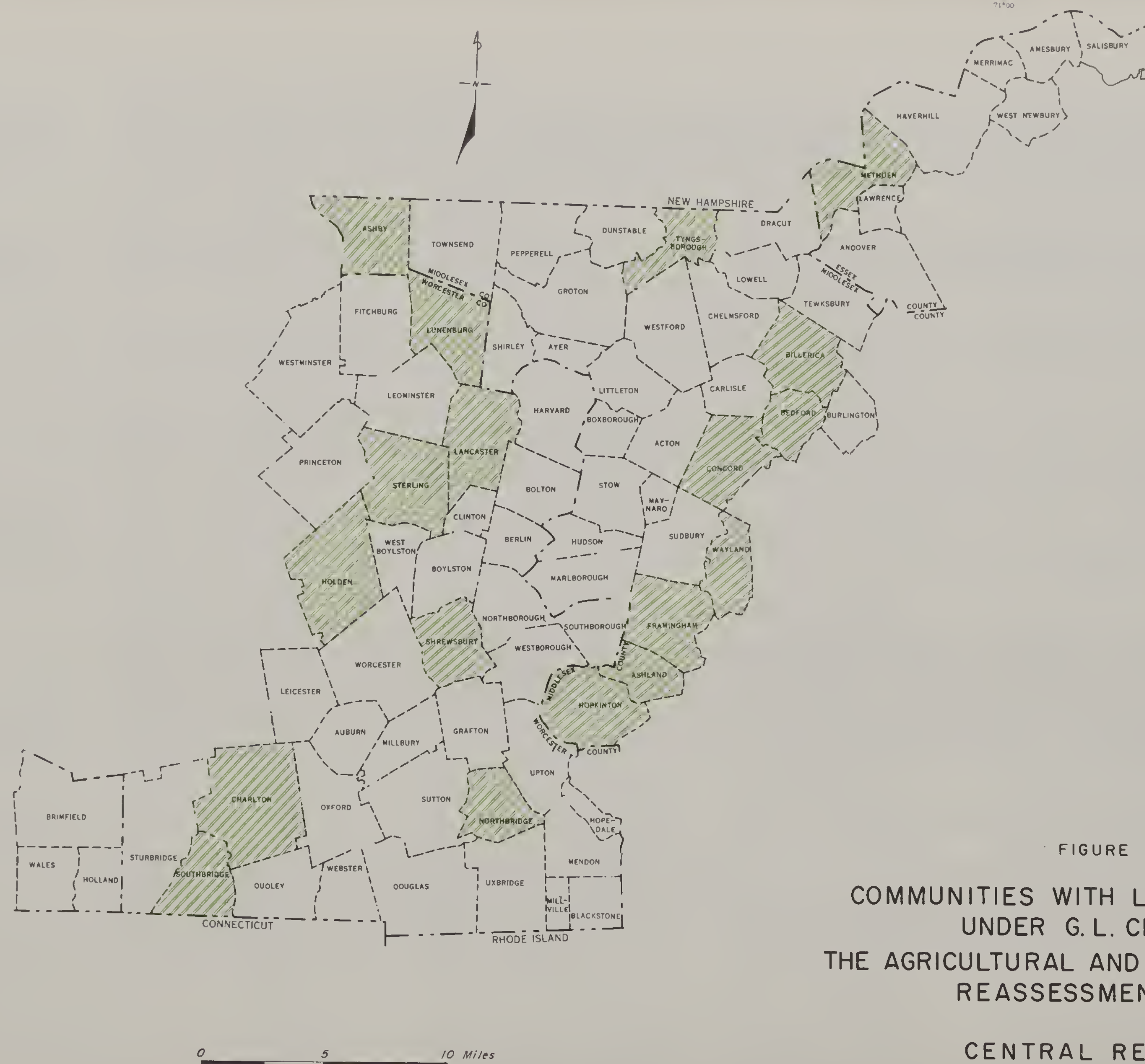

FIGURE 5.15

COMMUNITIES WITH LAND ASSESSED UNDER G. L. CH. 61A THE AGRICULTURAL AND HORTICULTURAL REASSESSMENT ACT

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DATE OF INFO JUNE 1977

TABLE 5.30 - cont. EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use	Municipalities	Zoning Enabling Act, Mass. General Laws Chapter 40A - The Act contains the basic authority for municipal zoning, predicated on the traditional police power concept of the promotion of health, safety, morals and general welfare. The Act authorizes municipalities to enact zoning laws designed among other purposes to lessen congestion in the streets, to conserve health; to secure safety from fire, panic and other dangers; provide adequate light and air; to prevent overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements; to conserve the value of land and buildings; to encourage the most appropriate use of land throughout the city or town; and to preserve and increase its amenities. Zoning may regulate and restrict the height, number of stories, and size of buildings and structures, the size of width of lots, the percentage of lot that may be occupied, the size of yards, courts and other open spaces, the density of population, and the location and use of buildings, structures and land for trade, industry, agriculture, residence or other purposes.
	Municipalities	Earth Removal-Mass. General Laws Chapter 40, Section 21 (17) and Chapter 40A, Section 2 - Municipal regulation of the extraction or removal of soil, sand, gravel, and other minerals was first carried on under the Zoning Enabling Act, which specifically authorizes municipalities to "regulate and restrict the...use of land...and (to) prohibit noxious trades within the municipality or any specified part thereof." The state legislature further empowered municipalities to enact nonzoning bylaws "prohibiting or regulating the removel of soil, loam, sand or gravel from land." In addition to exempting public land, the nonzoning bylaw must exempt earth removal which is part of site preparation for an approved subdivision or which is "the subject of a permit or license issued under the authority of the town." Because of these limitations, communities may and often do use both types of bylaws to ensure adequate coverage. Typically, such bylaws require a permit for earth removal and impose certain conditions upon the operation as a prerequisite to obtaining such a permit. Conditions may include, for example, control of drainage, maintenance of buffer zones along wetlands or public ways, screening and fencing, measures to reduce dust, limitation of the hours of operation; and grading, reloaming and reseeding after the work is done. Some eight municipalities have passed bylaws entirely prohibiting earth removal activities, except those absolutely necessary for preparation of a building site.
	Municipalities	Agricultural Preservation - Chapter 232 of the Acts of 1977 authorizes cities and towns to appropriate money for the purchase of development rights on farmlands.
	Municipalities & Mass. Dept. of Agriculture	Agricultural Preservation - Chapter 780 of the Acts of 1977 provides for the acquisition of agriculture preservation restrictions by the Commonwealth.

TABLE 5.30 - cont. EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, municipalities	Soil Survey - The SCS has the federal leadership for conducting the National Cooperative Soil Survey. In Massachusetts, the soil survey is carried on cooperatively with the Massachusetts Agricultural Experiment Station. Soil survey activities include the mapping, classification, correlation, and interpretation of soils according to national standards. The surveys are a basic scientific inventory of soil resources, based on soil properties. These surveys identify the kinds of soils, their extent, location and characteristics. Soil surveys play a vital part in planning by: 1. Providing a permanent inventory of the soil resources, 2. providing soil interpretations for various uses to guide planners at the local, regional, and state levels in making sound land use decisions for developing comprehensive plans, 3. providing data on the location of: a. wetlands, steep land, rocky land and areas with a high water table b. areas suitable for waste disposal c. areas that are suitable for use as residential, commercial, industrial, or school sites 4. providing many other soil interpretations that contribute to planning for a better quality environment. Many communities need, and want, soil survey information before the report is published in the usual manner. To provide this information ahead of the published report time, the SCS in Massachusetts prepares special soils reports for those communities which help pay for cost of preparation. A town soils report consists of a narrative description of each soil found within the community, copies of the soil survey mapping sheets and interpretative maps. These interpretative maps show the limitations of the soils for selected uses, such as sewage disposal, home sites or industrial sites. See Figure 5.16 for the status of the soil survey in the region.
	U.S. Soil Conservation Service, other USDA agencies, municipalities Conservation Districts	Resource Conservation and Development Areas - Resource Conservation and Development (RC&D) Areas are locally initiated, sponsored and directed programs which are planned to accelerate the conservation and development of natural resources; improve the general level of economic activity; and enhance the environment and standards of living. Each RC&D plan has its own unique goals. RC&D areas are sponsored by Conservation Districts, towns and county governments, and may include municipalities, state agencies, comprehensive planning agencies and local nonprofit organizations. In Massachusetts two RC&D areas have been established: The Berkshire-Franklin RC&D Area in Berkshire and Franklin Counties and the Pilgrim RC&D Area in Barnstable, Bristol, Dukes, Nantucket, and Plymouth Counties.

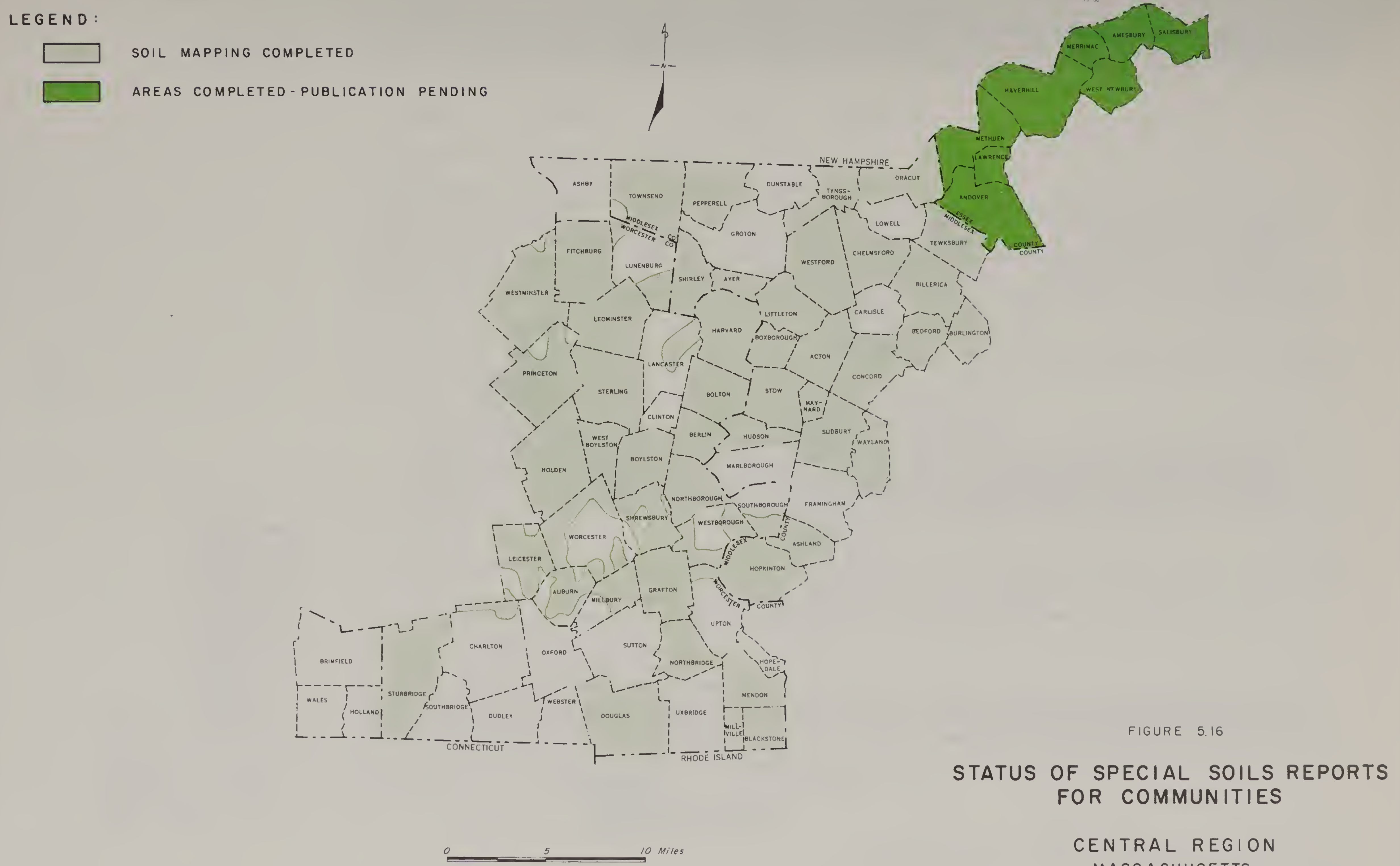

FIGURE 5.16

STATUS OF SPECIAL SOILS REPORTS FOR COMMUNITIES

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, Extension Service, Mass. Division of Forests and Parks, Mass. Division of Fisheries and Wildlife, Conservation Districts, municipalities	Natural Resources Planning Program - The NRPP provides for local communities to inventory their present natural resources, to rate those resources against standards and criteria, to determine the consequences of proposed actions on natural resource base, and to plan the most acceptable future course of action to maintain or improve the community's level of environmental quality. The Natural Resources Planning Program: 1. Gives citizens the major role, with local people doing most of the work, making all the decisions, and implementing any needed changes in community policies to meet their goals. 2. Closely relates the community's natural resources base to numbers of people the natural resources can safely support. 3. Provides help from regional technical teams that represent many agencies and disciplines. The teams are composed of personnel from the Soil Conservation Service, Cooperative Extension Service, Massachusetts Division of Fisheries and Wildlife, and Massachusetts Division of Forests and Parks. Other state and federal agencies assist as requested. The Conservation District accepts applications from communities requesting the program, screens the applications, establishes priorities for assistance by the technical teams, and coordinates agency assistance to the selected communities. 4. Includes standards and criteria for rating the resource base. 5. Is "open ended": Local citizens can continually monitor their area's natural resource condition and update land use plans as needed. One of the most important aspects of the program is its emphasis on citizen involvement. Local citizens provide the personnel to: (1) inventory, in detail, the present natural resources of their community (2) rate these natural resources against existing standards and criteria (3) identify problem areas (4) assess alternative courses of action (5) prepare a definite plan of action and then, (6) implement planned measures to maintain or enhance their natural resources to achieve the community's selected level of environmental quality. Whatever course of action a community chooses, through use of the program, the community will know in advance the likely consequences of those actions on the natural resource base. The following have started work under this program: Acton, Chelmsford, Sterling, Westminster Douglas, Methuen, Sudbury
	Farmers Home Administration, RC&D sponsors	Resource Conservation and Development Loans - These loans are to assist sponsoring public agencies in Resource Conservation and Development (RC&D) Areas. Loan funds may be used for (1) rural community public outdoor-oriented water-based recreational facilities; (2) soil and water, development, conservation control and use facilities; (3) community water storage facilities. Loans cannot exceed $250,000.

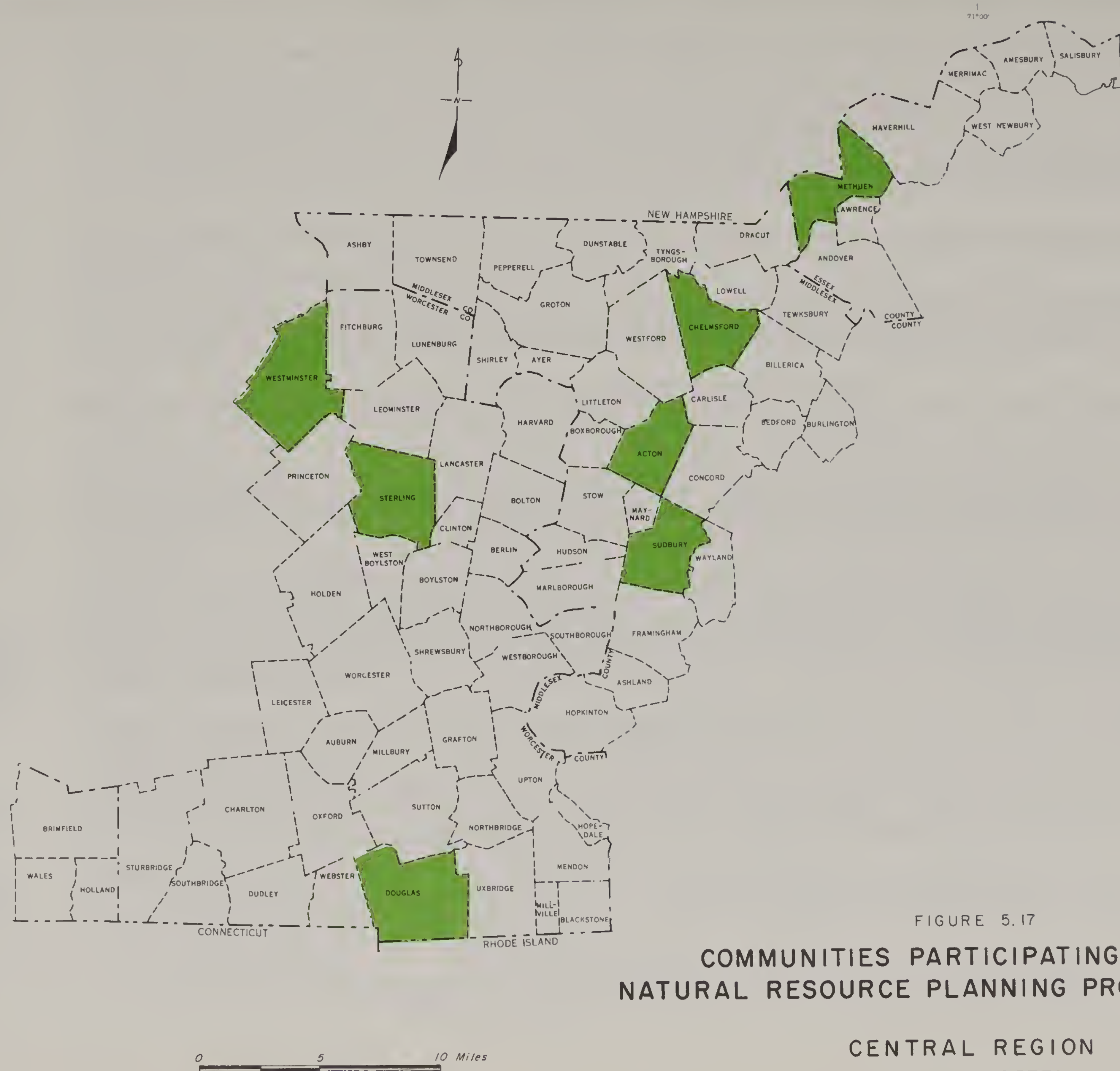

FIGURE 5.17

COMMUNITIES PARTICIPATING IN THE NATURAL RESOURCE PLANNING PROGRAM (NRPP)

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.30 - cont. EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service Extension Service, Mass. Natural Resources agencies	Natural Resource Inventories - These studies identify and describe areas with natural resource development potential within the community. Each area is described and its alternative development potentials are listed in a report. Opportunities and problems in the use of each site or areas are identified and discussed. The Soil Conservation Service, County Regional Extension Service, Massachusetts Division of Forests and Parks, Massachusetts Division of Fisheries and Wildlife and other agencies conduct natural resource inventories for communities. A community wishing a natural resource inventory requests help from the Conservation District which, in turn, arranges for the inventory. Status of the Natural Resources Inventory Program is shown on Figure 5.17.
Land Use Forest Land	U.S. Forest Service, Mass. Division of Forests and Parks, landowners	Renewable Resources Program - The Forest Resources Planning Act of 1974 provides for long-term planning for the management, protection and utilization of all renewable resources on forest land. The Forest Service and the Massachusetts Department of Environmental Management, Division of Forests and Parks, cooperatively conduct forestry programs on state and privately owned forest land. The forest resources of the Central Region also benefit from research in various aspects of forestry conducted at 80 different laboratories and other scientific facilities. These activities are grouped into five systems: recreation, wildlife, timberland and water, human and community development. Recreation System - The goal of this system is to increase the supply of outdoor recreation opportunities and services through programs which emphasize dispersed recreation. Assistance is given private forest landowners who are interested in helping provide public recreation opportunities, or integrate multiple uses into their forest management programs. Research is conducted to strengthen technology and understanding of recreation demands, trends, values and environmental impacts, as well as quantify and rank commodity and amenity values. Wildlife System - This system provides for increased use and enjoyment of wildlife while increasing both the diversity and numbers of fauna and the protection of threatened and endangered species. Technical assistance and financial incentives encourage nonindustrial private forest landowners to include habitat protection and development among their own management objectives. Research emphasizes habitat identification and improvement for endangered species and the impact of alternative forest practices on game and nongame habitats and populations. Timber System - The goal for the timber system is to increase timber supplies and quality to the point where benefits are commensurate with costs. Opportunities to increase timber supply exist on small private holdings, as well as, on Massachusetts state-owned forest areas. The program provides incentives for private timber landowners to grow commercial timber and for improved use of the trees and logs that are harvested. Major research includes better utilization of timber; improving the rates of timber growth and yield, improving the protection for forests from wild fire, insects and diseases; and proving better inventory and evaluation of resources.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use Forest Land cont.	U.S. Forest Service, Mass. Division of Forests and Parks, landowners cont.	Land and Water System - The land and water system is an aggregation of many basic stewardship and land treatment activities to meet minimum air and water quality standards. This system permits control of man-caused erosion on state and private forest lands through technical assistance and program support. Important areas of research include the nature and extent of nonpoint sources of pollution, improved logging practices for fragile soils and steep slopes, and improved efficiency of fire prevention and firefighting operations. Human and Community Development System - This system is concerned with the relationships between man and his forest environment. All renewable resource programs are focused to increase goods and services from forest land; this means serving employment, housing and other social needs. Assistance to communities is provided for urban and community forestry, rural community fire protection and land use planning. Conservation education and manpower training programs are designed to enhance the knowledge and skills of rural residents.
	Mass. Natural Resource Agencies	The Massachusetts Department of Environmental Management and the Massachusetts Department of Fisheries, Wildlife and Recreational Vehicles are applying multiple-use management to approximately 35,000 acres of forest land under their jurisdiction as authorized under General Law 132, Section 31, and General Law 131, Section 6.
	U.S. Agricultural Stabilization and Conservation Service, landowners	The Forest Incentives Program (FIP) provides cost-sharing assistance to landowners who undertake forestry conservation practices. Program objectives are to increase the production of timber and wood products to reduce and abate pollution of streams and other bodies of water by planting trees in disturbed areas and to benefit communities by providing wildlife and landscape beauty and increasing outdoor recreation opportunities. The cost for such practices is shared between the federal government and the landowner. Technical assistance is provided by the SCS and the Forest Service in cooperation with the Massachusetts Division of Forests and Parks.
Flooding	U.S. Soil Conservation Service, state and local governments, U.S. Forest Service	Public Law 83-566, The Small Watershed Protection and Flood Prevention Program - PL-566 provides federal technical, and financial assistance to states, local communities, conservation districts, and other groups in solving their land and water problems. Project purposes which may be included in a PL-566 watershed plan include: conservation land treatment, flood prevention, agricultural water management, industrial and municipal water supply, recreation and fish and wildlife. Flood prevention must be a major concern in each project. PL-566 watersheds are limited to 250,000 acres in size. The program applies to land and water resource problems which cannot be solved by individual landowners on their own property. The PL-566 watershed program helps improve the quality of the natural resource base, the quality of the environment and the quality of the standard of living by: 1. reducing erosion and sedimentation through the application of land treatment practices, 2. identifying flood hazard areas for flood plain management measures, 3. promoting proper land use and management, 4. improving agricultural water management practices, 5. providing multiple purpose reservoirs for recreation, fish and wildlife, and water supply, 6. reducing flood damages, hazards to life and health, and the inconvenience caused by flooding.

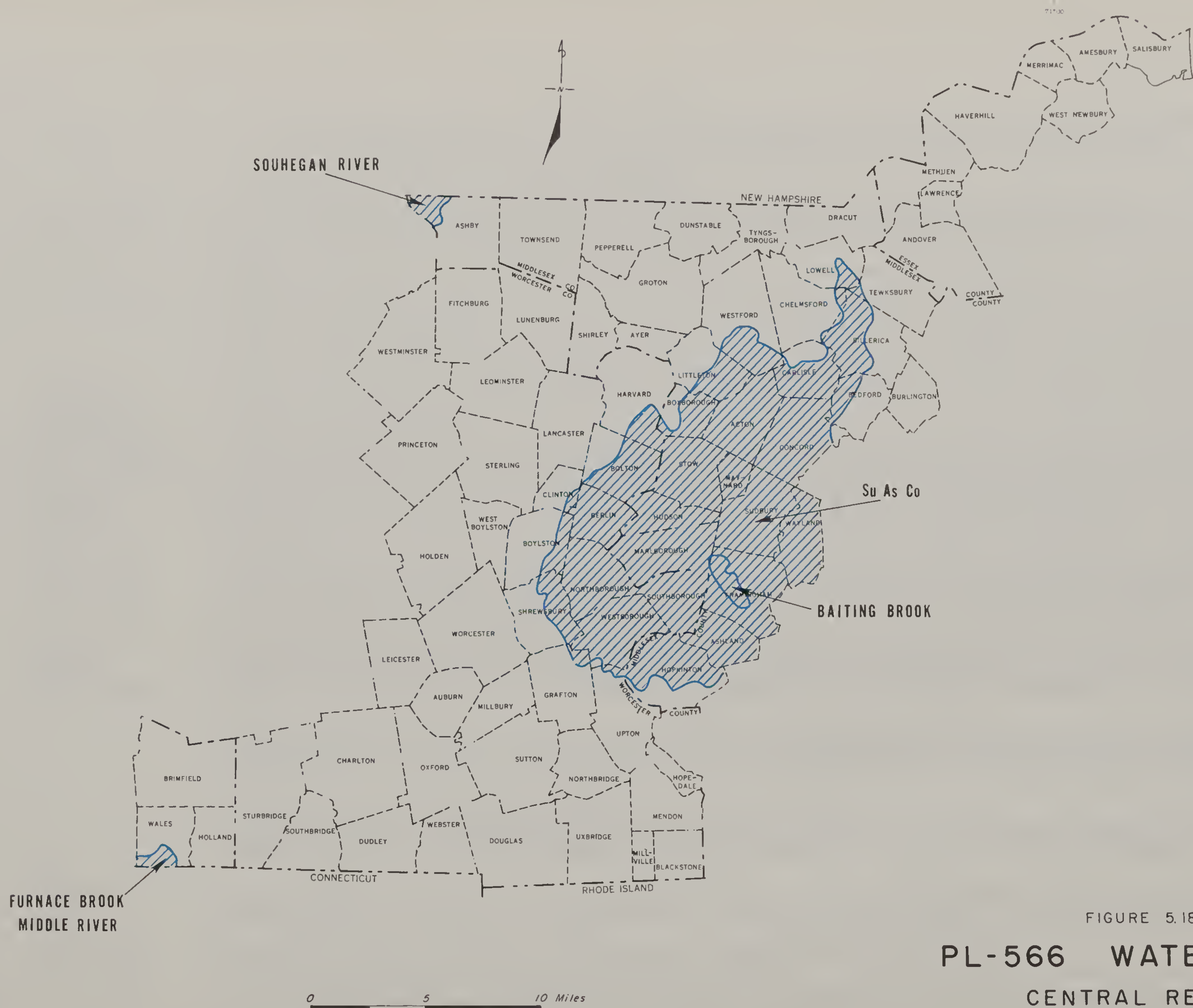

FIGURE 5.18

PL-566 WATERSHEDS

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding cont.	U.S. Soil Conservation Service, state and local governments, U.S. Forest Service cont.	In the Central Region four watersheds are, or have been, involved in the PL-566 program. See Figure 5.18 for location of these watersheds. The Baiting Brook Watershed Project in Framingham, Massachusetts was approved for installation in 1957. Primarily because of land rights problems, the planned structural measures were not implemented. A revised watershed plan is nearing completion that responds to changes that have since taken place. Measures include land treatment, a floodwater retarding structure, channel work, and culvert modifications. The project will reduce average annual floodwater damages to residences, roads and bridges, and commercial establishments an estimated 84 percent. Sponsors of the project are the town of Framingham and the Middlesex Conservation District. The SuAsCo (Sudbury, Assabet and Concord Rivers) Watershed Project in Middlesex and Worcester Counties, Massachusetts was authorized for installation in 1959. Installation of project measures is nearly complete in this 241,617 acre watershed with the last of the nine structures under construction. The Nashoba Recreation Development mentioned in the planning documents will not be constructed. The project provides recreation and fish and wildlife benefits and flood protection for residences, commercial and manufacturing establishments, utilities, roads, and bridges. Project sponsors include: Northeastern Worcester County and Middlesex Conservation Districts, Massachusetts Department of Environmental Management, Massachusetts Division of Fisheries and Wildlife, and the Massachusetts Water Resources Commission. In addition two other authorized watershed projects are partially within the region. Both of these projects are mainly in adjacent states. The Souhegan River project is in Middlesex County, Massachusetts and Hillsborough County, New Hampshire with the other project, Furnace Brook, is in Hampden County, Massachusetts and Tolland County, Connecticut. Only land treatment measures were planned for the Massachusetts portion of these projects.
	Farmers Home Administration, PL-566, local sponsors	Watershed Protection and Flood Prevention Loans - These loans provide assistance to local PL-566 sponsors to provide the local cost of improvements for flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water-based recreation, and water storage and related costs. Applicants must have authority under state law to obtain, give security for and raise revenue to repay the loan and operate and maintain the facilities to be financed. The total amount of loans outstanding in any one watershed is limited to $5,000,000.
	U.S. Department of HUD and municipalities	National Flood Insurance Program - As of July 1977 all but three towns in the region had joined the National Flood Insurance Program, and property owners can now purchase low cost flood insurance protection. In return for this federally-subsidized insurance, the towns are required to consider flood hazards before issuing building permits, subdivision approvals, or zoning variances. After detailed hydrologic and hydraulic studies are made, HUD will issue flood zone maps which accurately delineate the flood hazard area and depth of flooding. Local governments must then require all new construction be above the 100-year flood elevation. Most financial institutions must require that flood insurance be purchased on any property within the flood hazard zone on which mortgages are accepted. As a condition of participation in the National Flood Insurance Program, a community must adopt flood plain management regulations meeting minimum standards published by the Federal Insurance Administration.

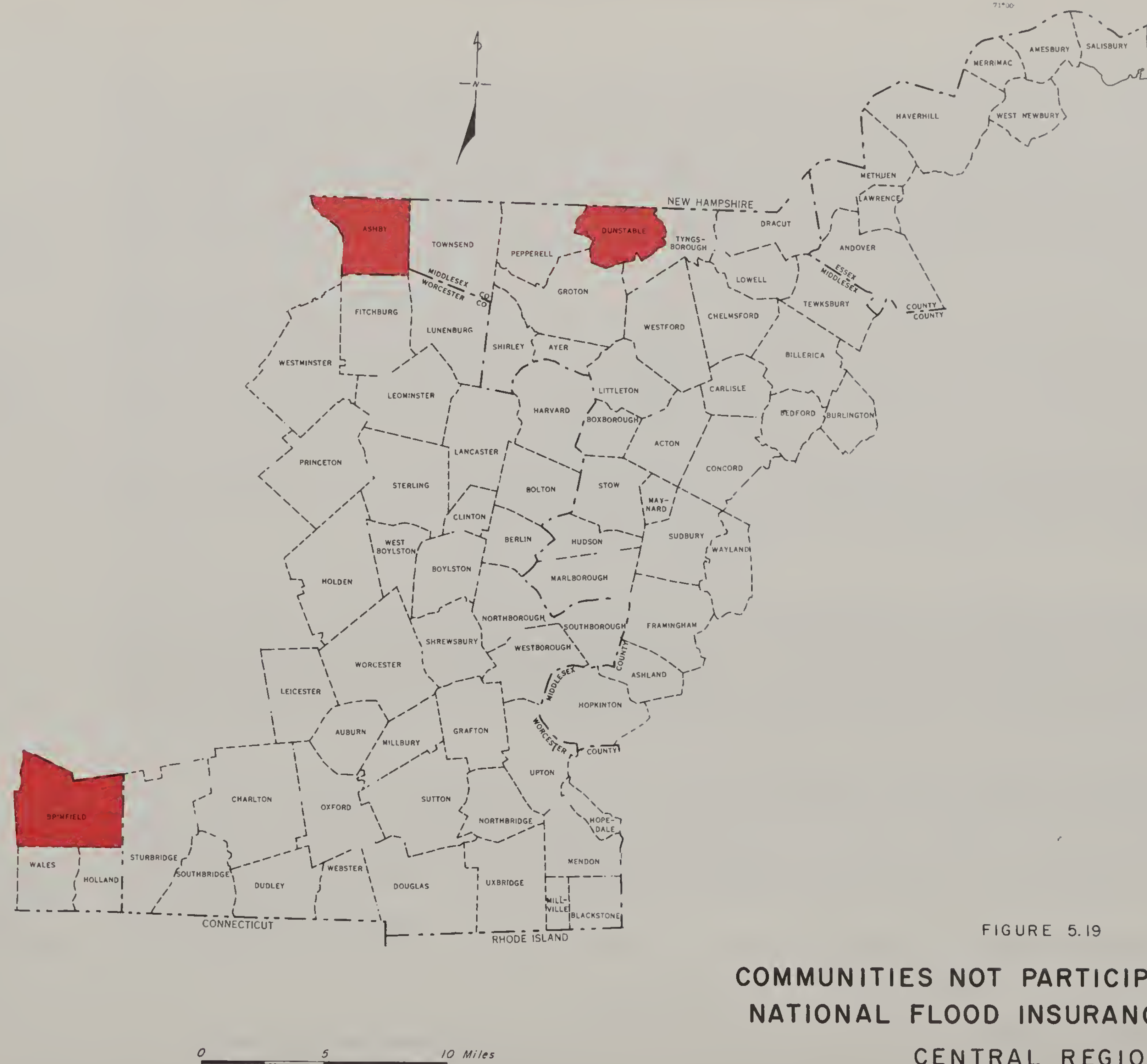

FIGURE 5.19

COMMUNITIES NOT PARTICIPATING IN THE NATIONAL FLOOD INSURANCE PROGRAM

CENTRAL REGION
MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding cont.	U.S. Department of HUD and municipalities cont.	A community must: (1) require building permits for all new construction and substantial improvements and (2) review the permit to assure that sites are reasonably free from flooding. For its flood prone areas the community must also require: (1) proper anchoring of structures, (2) the use of construction materials and methods that will minimize flood damage, (3) adequate drainage for new subdivisions, and (4) that new or replacement utility systems be located and designed to preclude flood loss.
	Mass. Department of Environmental Management, municipalities	Massachusetts General Laws, Chapter 780 Acts of 1977, the acquisition of Agricultural Preservation Restrictions is seen as a means of flood plain management by the State Department of Agriculture.
		Massachusetts General Laws, Chapter 131, Section 40A - The Inland Wetlands Restriction Act allows the Commissioner of Environmental Management, with the approval of the Board of Environmental Management, for the purpose of promoting the public safety, health and welfare, and protecting public and private property, wildlife, fisheries, water resources, flood plain areas and agriculture, can adopt, amend or repeal orders regulating, restricting, or prohibiting dredging filling, removing, or otherwise altering or polluting inland wetlands, or set encroachment lines on flood prone areas.
Erosion and Sediment	U.S. Soil Conservation Service, Conservation Districts, landowners	Conservation Operations Program - Landowners and communities are assisted in their efforts to control erosion and sediment and in other conservation efforts by the Conservation Districts. The districts coordinate assistance from the Soil Conservation Service, the Extension Service, the Massachusetts Division of Forests and Parks in cooperation with the U.S. Forest Service for forestlands, and from other state and federal agencies.
Wetlands	Mass. Department of Environmental Management, Department of Environmental Quality Engineering	Massachusetts General Laws, Chapter 131, Section 40 - The "Hatch Act" passed by the Massachusetts General Court in 1965, attempted to control the alteration of the wetlands. This act has been modified several times by the General Court. The comparable legislation in force today is Chapter 131, Section 40, of the General Laws as amended by Chapter 818 of the Acts of 1974 and Chapter 363 and 334 of the Acts of 1975. This act controls, but does not ban development on wetlands. The law requires that any person or governmental agency intending to remove, fill, dredge, or alter a wetland must insure, by following various procedural and technical steps, that the activity will have no adverse effect on water supplies, flood prevention, pollution prevention, or fisheries protection. In effect the act requires an owner desiring to develop his wetlands do so in accord with public interest and safety.
		Chapter 131, Section 40, now called the Wetlands Protection Act is administered by town or city conservation commissions or the city mayor or town selectmen in communities without conservation commissions. Appeals from local decisions go first to the Massachusetts Department of Environmental Quality Engineering and, if unresolved at that level the courts become the final arbitrators.
	Mass. Department of Environmental Management, municipalities	Massachusetts General Laws, Chapter 131, Section 40A - The Inland Wetlands Restriction Act (see above write-up under Subject - Flooding).
		Massachusetts General Laws, Chapter 130, Section 105 - A program similar to the Inland Wetlands Restriction Act is available to protect saltwater wetlands. Progress in implementing the saltwater wetlands restriction program has been more dramatic than the inland restriction program. About 2,400 acres of saltwater wetlands in the town of Salisbury have deed restrictions filed. This acreage constitutes most of the saltwater wetlands of the region.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Wetlands cont.	Mass. Division of Fisheries and Wildlife, Mass. Division of Forests and Parks	Massachusetts state agencies, in particular, the Division of Forests and Parks and the Division of Fisheries and Wildlife have active land acquisition programs. In addition, the Division of Fisheries and Wildlife has given emphasis to wetlands acquisition to permanently protect wetlands having primary significance to fish and wildlife.
	Municipalities	Many communities in the region have embarked on conservation area plans which attempt to preserve and enhance the natural resources, and especially the water resources, within the community. Usually this effort is spearheaded by city or town conservation commissions which are authorized to prepare conservation and outdoor recreation plans, acquire open space, land and water areas, prepare and maintain open space areas, and advise local officials on matters relating to conservation subjects.
	Mass. Division of Conservation Services, municipalities, Heritage Conservarion and Recreation Service	Federal and state cost sharing funds are available to the cities and towns for use in purchasing conservation, open space and recreation areas. The Division of Conservation Services administers the Massachusetts Self-Help Act (General Law, Chapter 40, Section 8C) and administers or coordinates the Land and Water Conservation Program of the Heritage Conservation and Recreation Service (U.S. Department of the Interior) within Massachusetts.
	U.S. Department of HUD, municipalities	In addition to acquisition programs, communities can adopt flood plain zoning ordinances to regulate the use of their wetlands and flood prone area. Restrictions imposed by the National Flood Insurance Program also tend to restrict wetland flood plain development. See the Flooding Section for more details on the National Flood Insurance Program.
	Interested Groups	The Massachusetts Audubon Society, Trustees of Reservations and other similar organizations assist individuals and municipalities in protecting the region's wetlands and other natural resources. These groups engage in various activities including environmental education; acquisition of wetlands, flood plain and other important natural resource areas; wildlife sanctuary and reservation management; and assistance to the region's cities and towns in their respective wetland and other resource programs.
Water Quality	Environmental Protection Agency, Mass. Division of Pollution Control, Mass. Division of Environmental Health, municipalities, industries	Restoration and maintenance of water quality has been the result of a combined effort by the federal, state, and local governments; and private industry. The primary federal agency concerned with water quality is the Environmental Protection Agency. The Massachusetts Department of Environmental Quality Engineering is the lead state agency. Important divisions include the Division of Water Pollution Control and the Division of Environmental Health.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Water Supply	U.S. Dept. of Commerce municipalities	Grants and Loans for Public Works and Development Facilities - This program provides grants of up to 50 percent of the development cost for such public facilities as water and sewer systems, and flood control projects. Jurisdictions designated as redevelopment areas may qualify for grants and loans. These areas may be counties, labor areas, or larger cities characterized by high unemployment or low family income. Severely depressed areas that cannot match federal funds may receive supplementary grants to bring the federal contribution up to 80 percent of the project cost.
		Loans are also available for public works and development facility projects. These loans may pay the full cost of a project and may run for as long as 40 years, the interest being determined by government borrowing costs. A community that is unable to raise its share of the eligible project cost may receive a grant for 50 percent or more of the project and a federal loan for the remainder of the cost.
	Mass. Water Resources Commission, municipalities, other units of government	Water Favorability Studies - Under General Laws Chapter 21, Section 9, this program provides for studies of water favorability in areas of the Commonwealth where there may be a need for such a determination.
		Upon application of a county, conservation district or upon joint application by two or more municipalities, fire districts or water districts or regional district planning commissions, the Water Resources Commission may contract with any agency of the United States or with private firms to conduct water favorability studies within the jurisdictions indicated in the application. The applicants must provide one-half of the nonfederal cost, and special funding must be provided by legislation for the remainder.
		Massachusetts General Laws Chapter 767 Acts of 1970, authorizes the Water Resources Commission to acquire water impoundment sites to meet the future water resource needs of the Commonwealth.
	Environmental Protection Agency, municipalities	Drinking Water Supply-Technical Assistance - Under provisions of the Public Health Service Act (PL 93-523, as amended) the Environmental Protection Agency assists state and local water supply regulatory agencies and public water supply regulatory agencies and public water supply operators and officials to assure that water supply systems serving the public meet minimum National standards for the protection of public health.
	Farmers Home Administration, municipalities	Water and Waste Disposal Systems for Rural Communities - These loans and grants may be used for the installation, repair, improvement, or expansion of a rural water system including distribution lines, wells and pumping facilities. Installation, repair or improvement of a rural waste disposal system are also included. Loans may not exceed $20,000,000. Grants are limited to $1,000,000.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Recreation	Farmers Home Administration, landowners	Recreation Facility Loans - These loans are intended to assist farm owners to convert all or portions of their farms to income-producing outdoor recreational enterprises to supplement farm income. Funds may be used to: (1) develop land and water resources, (2) repair and construct buildings, (3) purchase land, equipment, livestock, and related recreation items. Recreation enterprises that may be financed include: campgrounds, horseback riding stables, swimming facilities, shooting preserves, nature trails, and lakes and ponds for boating and fishing. Loans cannot exceed $100,000.
	Landowners	Massachusetts General Laws, Chapter 27, Section 17C - The act limits the liability of landowners who allow recreational use of their property by the public. The obvious purpose of the act is to eliminate the liability that serves as a deterrent to providing recreational opportunities and which encourages the posting of land against trespass.
	U.S. Forest Service, Mass. Division of Forest and Parks, landowners	Recreation System of the Forest Service Renewable Resources Program assists landowners to provide forest land recreation opportunities. See the Land Use - Forest Land Section for more details on the Renewable Resources Program.
	Mass. Department of Environmental Management	An Act to Protect Scenic and Recreational Rivers and Streams - This act authorizes the Commissioner of Environmental Management to adopt, amend, or repeal orders regulating or prohibiting dredging, filling or altering scenic and recreational rivers and streams. A Pilot Program under this act is being developed for the North River.
	Mass. Division of Conservation Services, municipalities	Massachusetts Conservation "Self-Help" Act (G.L. Chapter 132A, Section 11 as amended) - The Massachusetts "Self-Help" Program makes funds available to communities for acquiring conservation-recreation lands. Improvements on land acquired with the help of the Self-Help Program, may include such things as informal playfields, trails, access roads comfort stations, water impoundments, or wells and campsites. Reimbursements are available only to those municipalities which have established conservation commissions by accepting the provisions of Chapter 40, Section 8C of the General Laws. In addition, a Natural Resource Open Space-Recreation Plan must be filed with the Division of Conservation Services. The land must be controlled by the Conservation Commission after purchase by the community and accessible to any resident of the Commonwealth. An approved project may receive up to 50 percent of the cost of acquisition. If the community is also receiving federal funding assistance under a federal program, the addition of Self-Help funds may involve reimbursement of up to 75 percent of the total cost of the project.

NOTES

1/ Same as No. 10, Chapter 4.

2/ From conversation with D. Schmidt, Massachusetts State Building Commission, May 23, 1977.

3/ Christensen, Robert L., John H. Foster, and Donald R. Marion, Self-Sufficiency for Food in Massachusetts (Part II), Cooperative Extension Service, University of Massachusetts, U.S. Department of Agriculture and County Extension Services Cooperating, Amherst, Massachusetts, 1976.

4/ Black, John Donald, The Rural Economy of New England: A Regional Study, Harvard University Press, Cambridge, Massachusetts, 1945, p. 383.

5/ 1974 Census of Agriculture, Massachusetts.

6/ Platt, et al., op. cit., p. 7.

7/ Barlowe, Raleigh and Theodore R. Atter, Use-Value Assessment of Farm and Open Space Lands, Michigan State University Agricultural Experiment Station, Research Report 308, East Lansing, Michigan, September 1976, pp. 30-31.

8/ Marion, Donald R., John H. Foster, and Robert L. Christensen, Self-Sufficiency for Food in Massachusetts, Food and Resource Economics Extension Newsletter, Cooperative Extension Service, University of Massachusetts, U.S. Department of Agriculture, and County Extension Services Cooperating (Amherst, Massachusetts), September 1976, p. 9.

9/ Kingsley, Neal P., "The Forest Landowners of Southern New England," USDA Bulletin NE-41, 1976.

10/ North Atlantic Regional Water Resources Coordinating Committee, North Atlantic Regional Water Resources Study, Appendix Q, Erosion and Sedimentation, May 1972, p. Q-3.

11/ These standards were first established by the Massachusetts Division of Water Pollution Control in 1967. The standards in effect now were adopted in May 1974 and published in "Rules and Regulations for the Establishment of Minimum Water Quality Standards and for the Protection of the Quality and Value of Water Resources," Commonwealth of Massachusetts, Water Resources Commission, Division of Water Pollution Control, May 1974. Classifications based on the 1967 Standards remain in force until reclassified under the 1974 Standards.

12/ Not defined in the May 1974 "Rules and Regulations.....," but included here to cover present water quality below the standards.

13/ Oatis, P.H. "Quabbin: The Making of a Fishery," Massachusetts Wildlife, Massachusetts Division of Fisheries and Wildlife, Boston, March-April 1974.

14/ Massachusetts Division of Fisheries and Game. Statewide Small Game Harvest, Federal Aid Project W-35-R, Progress Report, 1971.

15/ Wetland types are taken from Wetlands of the United States by S. P. Shaw and C. G. Fredine, Circular 39, Fish and Wildlife Service, U.S. Department of the Interior, U.S. Government Printing Office, Washington, D.C., 1971.

16/ MacConnell, W. P. and W. Niedzwiedz, Remote Sensing 20 Years of Change in Worcester County, Massachusetts, 1951-1971, Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst, 1971.

CHAPTER 6

FUTURE-WITHOUT-PLAN CONDITION

6.1 DEFINITION AND USE

The Principles and Standards for Planning include a major step to "evaluate resource capabilities and expected conditions without any plan." This involves an appraisal of future economic and environmental conditions expected without a plan, so that these conditions may be compared with those desired by people for the planning area.

Thus, for a selected future date, projections are made which reflect the inventory and capabilities of the natural resources, the trends which are likely to continue into the future, and the effects of any authorized projects which may alter conditions in the region. The "without-plan" portion of the title implies that the future conditions are to be projected without consideration of any projects which may be in planning stages. This restraint makes it possible to project future conditions which could be expected in the absence of any new programs or projects. Obviously, it makes little sense to embark on an elaborate planning process followed by detailed implementation schemes, if existing authorized projects combined with expected changes will meet the projected demands in a resource area.

The Massachusetts Water Resources Study is concerned with projecting future conditions to the year 1990.

6.2 IMPLICATIONS OF ECONOMIC AND SOCIAL PROJECTIONS TO ENVIRONMENTAL CONSIDERATIONS

As Chapter 4 pointed out, 1990 population projections show an increase of 230,181, or nearly 18.4 percent greater than the 1975 population of 1,255,076. Economic activity is also projected to increase. The potential impact on the environmental quality in the region need not be adverse. Taking the 1990 land use projections, and subtracting agricultural land, lands of state and local importance (including forest land presently located on these lands), wetlands, and water, 663,205 acres remain which are conducive to development. This figure would have to be

adjusted downward to take into consideration slopes and soil conditions not amenable to development or septic systems. On this basis, it is concluded that enough land resource exists to adequately support future population and economic growth. What is required is land use control or guidance to insure that future development does not adversely affect environmental quality.

6.3 DESCRIPTION OF FUTURE-WITHOUT-PLAN CONDITION

6.3A. Agricultural Land

As noted in Chapter 5, existing land use laws and regulations have been incorporated in the projections (Chapter 4). The statutes that appear to be the most effective are those that have preservation as their primary objective. This explains, in part, why wetland projections show a small decline relative to the historical trends. Agriculturally related land use laws seem to have little effect on the losses of such land; thus, the historical trend was adjusted only to weigh the recent trends more heavily than the earlier trends.[1/] It should be noted that if current trends continue, the region will continue to lose agricultural land.

With respect to stated public policies and goals, especially regarding agricultural preservation and proper siting of future developments, the future is cloudy, at best. Subdivision control statutes are limited, since approval is not required if such developments occur along existing public roads. Unless additional controls are incorporated, land use guidance will not be forthcoming and, thus, there is some possiblity that the resource base and the environment may be adversely effected. Without such guidance, review, or approval procedures, impacts of development will remain somewhat indeterminate.

In December of 1977, the General Court of Massachusetts enacted legislation[2/] which would provide $5,000,000 to support a pilot development rights program wherein said rights are purchased from private landowners. The impact upon agricultural land preservation could be significant. For example, ownership costs (taxes) would be lower because assessments would be based upon agricultural production value rather than market value for developable land. Since development would not be permitted, farmland would, therefore, be less costly to purchase which may result in lessening the barriers to entry.

6.3B Forest Land

To determine the future-without-plan condition, it was assumed that forest land will continue to decrease at the low rate of approximately 338 acres per year, and that forest management efforts will continue at about 1976 levels. Presently, an estimated 133,000 acres are assumed to be under some type of forest management. The loss of forest land to

urbanization will increase if the present efforts to maintain the farmland base are successful.

Wood Products -- Future urban development will have two effects on wood product production. It will decrease both the area available for wood production, and the average productivity of the region. Sites that are the best for growing trees are among the best for development. These sites will be among the first to be lost to urban expansion and the future productivity of the region will decrease. Only 19 percent of the trees removed in land clearing operations are utilized for forest products including fuelwood.[3/] So, land clearing does not contribute significantly to wood product production in the region.

Given the present support level for programs to provide incentives and to educate landowners on forest management, many will continue to let their trees grow unmanaged. Landowner attitudes will discourage new wood-using industries from coming into the region, and there will continue to be a lack of a market for low quality products.

Fuelwood harvesting will increase because of the energy crisis, but this increase could be offset by the decrease in forest land area.

Future wood product production should remain constant or decrease slightly, given the above assumptions. The harvest will remain at about 3.4 million cubic feet per year, which will affect some 6,900 acres of forest land annually.

Water -- As long as an acre of land is in forest cover and a good forest floor is present, it will produce good quality water. Forest land will remain the dominant land use in the region; therefore, the forest resource will continue to supply a good quantity of high quality water.

Forage -- Grazing of livestock on forest land is not a major use now, nor will it become a major use in the future.

Wildlife -- The amount and kind of wildlife available in an area depends on the habitat in the area. The majority of the land area is forested, and there are many wetlands to provide diversity needed for good habitat. This is expected to continue into the future. With the small amount of harvesting taking place, the forests will mature, and this will change the kind of wildlife found in the area. As one stage of forest succession goes to another, the animal community associated with the first also gives way to a new community.

Even though wildlife will remain in the region, access to the wildlife for both consumptive and nonconsumptive uses will continue to be a problem. As the area becomes more urban and ownerships become smaller, there will be more posting of land.

Recreation -- Future recreation needs will not be fully met through the year 1990.[4/] The forest land has the physical capacity to support the development of almost any required number of campsites, picnic areas, and trails. The problem will continue to be one of public access and an insufficient number of developed facilities. (See Table 7.4, Recreation Needs.)

6.3C Inland Flooding

As a result of the National Flood Insurance Program, many communities in the region are adopting land use regulations which will severely restrict the development of flood prone areas. Flood plain development in towns which are not enrolled in the Flood Insurance Program will be limited by the unavailability of federally supervised mortgage money in flood prone areas. Also many state programs have been established which will curtail development in flood plains, and communities are becoming more cognizant of the importance of flood plain management to discourage improper land use.

As a consequence of the situation stated above, inland flood damage potential in most of the Central Region is not expected to significantly increase by 1990. Changes could occur in individual subwatersheds, if unexpected industrial or commercial development were to occur in the old mill buildings which are located along the region's rivers. Inflation will, of course, increase the total dollar damage potential, but the physical damage is expected to remain essentially unchanged.

There are three exceptions to this "future-without" plan condition. The first is the Baiting Brook Watershed located in Framingham, Massachusetts (subwatershed SU-16). This watershed has been approved for construction of a single purpose floodwater retarding structure, channel enlargement, and culvert improvement. Construction of this project under PL-566 will significantly reduce flood damage potential.

The second exception is on the Sudbury River (subwatershed SU-17) in Saxonville. A local protection project has been approved under the auspices of the Corps of Engineers which will reduce flood damages in this watershed.

The final and most significant exception is on the North Nashua River (subwatershed NA-2, 3, and 4) where the Corps of Engineers is now conducting detailed studies. Since these studies are not finalized, no reduction figure has been shown in the table. If alternatives being developed are implemented, the major portion of damages will be reduced.

Flood damages anticipated in 1990 are indicated in Table 6.1.

TABLE 6.1 PROJECTED 1990 FLOOD DAMAGES 1/

Subwatershed	100-Year Flood Damage ($)	Average Annual Damage ($)
	-Merrimack River Watershed- 2/	
ME-1 (Rowley River)		3/
ME-12 (Cow Pond Brook)		3/
ME-13 (Merrimack River)		3/
ME-14 (Stony Brook)		3/
ME-15 (Merrimack River)	1,444,300	68,700
ME-18 (River Meadow Brook)		3/
ME-19 (Shawsheen River)	1,242,000	74,500
ME-20 (Merrimack River)		3/
ME-21 (Merrimack River)		3/
	SuAsCo Rivers Watershed	
	-Sudbury River Watershed-	
SU-16 (Baiting Brook)	114,800	23,500
SU-17 (Sudbury River)	5,707,300	342,400
	-Assabet River Watershed-	
AS-17 (Assabet River)	112,700	6,800
	-Concord River Watershed-	
CO-17 (Concord River)	805,000	48,300
	-Blackstone River Watershed-	
BL-61 (Ramshorn Brook)	285,200	17,100
BL-62 (Blackstone River)		3/
BL-63 (Quinsigamond River)	363,400	21,800
BL-64 (Blackstone River)	958,000	57,500
BL-65 (Mumford River)	2,066,000	124,000
BL-66 (West River)		3/
BL-67 (Mill River)		3/
BL-68 (Abbott Run)		3/
	-Thames River Watershed-	
TH-1 (Furnace Brook)		3/
TH-1A (Quinnebaug River)	844,100	50,600
TH-2 (French River)		3/
	-Nashua River Watershed-	
NA-1 (Soughegan River)		3/
NA-2, 3 and 4 (North Nashua River)	Detailed studies being conducted by Corps of Engineers.	
NA-5 (Quinapoxet River)		3/
NA-6 (Stillwater River)		3/
NA-7 (Nashua River)	201,300	12,100
NA-8 (Catacoonamug Brook)	115,000	6,900
NA-9 (Mulpus Brook)		3/
NA-10 (Squannacook River)	227,700	13,700
NA-11 (Nashua River)	281,700	16,900

1/ Price Base 1976.
2/ Does not include main stem damage.
3/ Average Annual Damage less than $5,000.

6.3D Erosion and Sediment

Erosion problems resulting on logging roads, skidtrails, roadbanks, unpaved roads, gravel pits, streambanks and from improper harvesting of timber, are expected to be managed and controlled by existing programs and services. Existing programs, as presently administered, will not be able to bring erosion losses to an acceptable level on all cultivated farmland, construction areas, or related critical erosion areas, such as road cuts with unstable slopes, sand dunes, and utility rights-of-way. Without increased funding and emphasis, the Conservation Operations Program of the Soil Conservation Service is expected to meet less than 35 percent of the existing land treatment needs on cultivated cropland by 1990. Also without action to regulate and modify development practices, erosion losses of more than 175,000 tons per year are expected from the 4,500-acres of land being converted to urban uses each year.

6.3E Wetlands

The future status of wetland loss in the region will be largely determined by the effectiveness of the Wetlands Protection Act and the Inland and Coastal Wetlands Restriction Acts. The ownership and zoning of the wetlands and the HUD Flood Insurance Program are also factors in determining the potential for loss of wetlands.

Wetlands Protection Act[5/] applications have been reviewed for a sample of 85 communities across the state. The sample indicates that in 1976 about 290 acres of the 80,800-acres of inland wetlands in the sampled communities had received alteration permits. An analysis of building permit data for the last 10 years showed that construction expenditures for 1976 were being made at a rate nearly 15 percent above the 10-year average. In view of this, the 1976 loss of inland wetlands figure, approximately 0.4 percent per year, is considered appropriate for use here.

Publicly owned wetlands are in less danger of being lost to development than privately owned areas. Surveys of the inland wetland areas in the Central Region indicated over 14 percent were owned by government or some quasi-public body, such as the Massachusetts Audubon Society or Trustees of Reservations. Zoning can also affect the rate of wetland loss. Conservation and flood plain zoning of wetlands will tend to preserve wetland areas, while industrial or commercial zoning indicates a potential danger to the wetlands. Nearly 21,000 acres or 26 percent of the inland wetlands are under special regulations, such as flood plains, wetlands, and conservation or other zoning.

A projected inland wetland loss of 4,600 acres in the Central Region between 1977 and 1990 was estimated by considering historical wetland losses adjusted for variation in construction activity and the effects of public ownership and protective zoning.

Salisbury, the only town with coastal wetlands in the region, has had its tidal wetlands restricted under Massachusetts G.L., Ch. 130, Sec. 105, the Coastal Wetlands Restriction Act. This study will, therefore, concern itself with the region's inland wetlands only.

Discussions with personnel involved with the inland wetland restriction program indicated that, if the programs continue at their present rate, restrictions will be imposed on approximately 250 additional acres of privately owned inland wetlands in the region by 1990. Presently, only one town has wetlands restricted under the Massachusetts Inlands Wetlands Restriction Program, G.L., Ch. 131, Sec. 40A. It is projected that 12 towns within the Nashua study area will have wetlands restricted under this program by 1990. The present and projected status of inland wetlands are given in Table 6.2.

TABLE 6.2 1990 INLAND WETLANDS SITUATION & PROJECTIONS

	Acres	Percent of Total
Present status (1977)	82,019	100.
Wetlands in:		
Public or quasi-public ownership	11,569	14.1
In conservancy zones 1/	20,970	25.6
G.L., Ch. 131, Sec. 40A restrictions on privately owned wetlands 2/	691	0.8
Wetlands protected only by G.L., Ch. 131, Sec. 40 in 1977	48,789	59.5
Projections (1977 to 1990)		
Additional public acquisition	7,700	9.4
Additional Ch. 131, Sec. 40A restrictions 2/	9,250	11.3
Projected loss of wetlands by development	4,590	5.6
Wetlands protected only by G.L., Ch. 131, Sec. 40 in 1990	27,249	33.2

1/ Does not include wetlands in public or quasi-public ownership or wetlands restricted under Massachusetts G.L. Ch. 131, Sec. 40A.

2/ Does not include wetlands in public or quasi-public ownership.

6.3F Water Supply

The draft Massachusetts Water Supply Policy Study[6/] concluded that 33 towns (42 percent) of the region will have an adequate supply of water in 1990. Twenty-nine towns (37 percent) will have a deficiency. Deficiencies range from less than 1 million gallons per day (mgd) for 15 towns to over 5 mgd for two towns. Except for Leominster and Holden, the towns predicted to have the greater water deficiencies by 1990 are along the eastern side of the region in the SuAsCo and Merrimack basins.

Seventeen towns or 22 percent of the region uses either individual wells or private systems or there is insufficient data to project needs for these towns. Proposals have been presented to alleviate some of the deficiencies by improving distribution systems, promoting conservation of water, exploring for ground water resources, and by possible utilization of additional surface water storages. Various studies and proposals have been made, producing few actual commitments which will have any far reaching effects on the predicted shortages.

The Massachusetts Executive Office of Environmental Affairs has just completed a "Water Supply Policy Study" for the Commonwealth. In this policy (pages 115-119), they recommend the following be established as the Commonwealth's policies for Water Supply:

4.C.1. Recommended Supply Management Policies

It is the policy of the Commonwealth to:

1. Require that water utility systems and those concerned with private supplies of water continue to give paramount consideration to health and safety needs. High priority should be given to insuring that water supplies are developed to meet such needs, particularly where imbalances exist and where a complementary demand management policy is in effect.

2. Guide and control supply planning by water utilities through conditional grants, financial incentives, and state review and approval procedures.

3. Encourage and assist water utilities to draw upon water sources within their own watersheds. Before allocation of the water resources of any of the Commonwealth's 12 major watersheds for interbasin transfer, the receiver shall demonstrate, pursuant to the Massachusetts Environmental Policy Act, that environmental effects are within acceptable limits; that local options have been exhausted, including efforts to preserve and restore potential ground and surface water supplies within the acquiring basin, and to maintain and restore the function of watershed areas; and that effective water conservation measures have been established.

4. Encourage the planning of local water supplies and watersheds to include, when consistent with Policy 4.C.1.1., multiple uses such as recreation, fish and wildlife habitat maintenance, protection of natural systems, and enhancement of aesthetic values.

5. Establish standards for and monitor minimum stream flows and pond or lake levels, and regulate withdrawals of ground and surface water to assure preservation of water-dependent natural areas, coordinating the monitoring of interstate streams with other states.

6. Encourage and assist water supply utilities to: develop or expand existing and new groundwater resources prior to seeking additional surface supplies; develop the multiple use potential of new and existing surface supplies in a manner consistent with Policy 4.C.1.1., such as establishing adequate facilities for treatment of the water; acquire, protect for quality, and manage the recharge of groundwater areas and watersheds to the extent necessary to postpone treatment as far as possible; and enhance potability and avoid contamination through the rehabilitation and improvement of supply facilities.

7. Include desalination as an integral part of long-range supply planning.

4.C.2. Recommended Demand Management Policies

It is the policy of the Commonwealth to:

1. Require statewide water conservation efforts, including the use of water saving appliances in all new construction, maximization of industrial and commercial multiple usage of water, and reduction of evaporative uses where feasible. Require the MDC, and all regional and local water suppliers to institute mandatory conservation measures consistent with the statewide water conservation program, applying to those efforts the criteria of achievement of such estimates of minimum water needs as the state, through the Water Resources Commission, may establish.

2. Require metering of all water utility deliveries and accelerate programs to install, maintain and replace meters in all local systems, giving priority to systems having the greatest amount of unaccounted-for water.

3. Require the rehabilitation of supply and distribution facilities which show large quantities of unaccounted-for water.

4. Encourage and assist water utilities to promote recycling of industrial process water and renovated municipal wastewater.

5. Require the Water Resources Commission to study water rates set by all publicly and privately owned utilities and recommend legislation on pricing, consistent with state water policy.

4.C.3. Recommended Administrative Management Policies

It is the policy of the Commonwealth to:

1. Encourage new programs and new financial commitments by the federal government in support of state and local comprehensive water resource planning, protection, and management activities. Such federal programs for water resources should be of the "block-grant" type permitting maximum flexibility to state governments in their formulation and administration.

2. Centralize department-level water resources planning, policy making and implementing in a single agency charged with the following responsibilities:

    - to prepare and maintain an assessment of water resources by watershed areas;
    - to coordinate and guide watershed planning;
    - to administer technical assistance and grant programs;
    - to prepare "water budgets" and plans for all water uses, including recreational waters;
    - to advise the Secretary of Environmental Affairs on water rights and water allocation questions;
    - to develop a formal process to deal with interbasin transfers and recommend agreements acceptable to all parties in specific interbasin transfer cases;
    - to monitor stream, pond, lake and aquifer withdrawals and the treatment thereof;
    - to review local water rates;
    - to develop and maintain and on-going community liaison program; and

- to regulate and administer such other matters as may affect the public health, safety, and welfare.

3. Until the establishment of a centralized water resources agency, authorize and direct the Water Resources Commission to take the following high priority actions to:

   a. Initiate a statewide water conservation program.

   b. Provide technical assistance to local communities, particularly for monitoring the quality of all water supplies, for advising on local supply options, for securing federal and other grant programs, and for conducting conservation programs.

   c. Initiate state level responsibilities for broad, long-range water supply planning, coordinating with regional planning agencies, and using defined watershed areas for basic analysis.

   d. Institute a process which effectively provides for public input in the review and arbitration of water rights questions among competing uses and users; in advising the legislature on questions of water allocation among communities; and in studying and recommending changes needed to administer state policy.

   e. Establish a process for planning and development of water resources and related activities at the local, regional, and state levels which involves citizens and which assures full review and consideration of environmental factors and values, land use controls, and techniques and institutional procedures (such as advance land acquisition) to minimize future costs and disruptions associated with development. Assure that the Secretary of Environmental Affairs, in designated areas of critical environmental concern, considers water resources and water supply values.

   f. Encourage regionalization of water supply systems where necessary, following standards of economic and technical feasibility, and in accordance with state growth, environmental protection, and water policy.

Information concerning potential surface water reservoir sites which appear to be suitable for development as municipal water supply reservoirs is found in Appendix A of this report.

6.3G Water Quality

An objective of the Federal Water Pollution Control Act Amendments of 1972 is the restoration and maintenance of the chemical, physical and biological integrity of the nation's waters. To achieve this objective, two major goals were established: (1) to attain swimmable-fishable waters by 1983, and (2) to achieve zero discharge of pollutants by 1985.

Point sources of pollution have been the major emphasis of the clean-up efforts to date. Hundreds of millions of dollars have been, and will continue to be, spent to meet the enormous costs involved in constructing and operating wastewater treatment plants.

Although the objective of the 1972 Amendments to the Water Pollution Control Act will be difficult to achieve and expensive, public sentiment for clean water is overwhelming. Major pollution problems still exist in the Blackstone, Nashua, and Merrimack Rivers. These are areas close to heavy concentrations of population and, thus, in areas where the demand for clean water for other uses is also great.

We concluded that the existing programs, authorities, and institutions are adequate to meet the water quality goals. "The basic need is for better use of these (existing) tools, not more tools."

Alternatives for meeting the remaining water quality problems are presented in detail in the following studies: Blackstone River Basin, SENE Study; Merrimack River Basin (which includes the Nashua, Concord, Sudbury, and Assabet River Basins), the Merrimack - Designs for a Clean River, U.S. Army Engineer Division, North Atlantic Corps of Engineers; Thames River Basin, 201 and 208 Studies.

The subject of water quality will not be carried further in this report except when it overlaps another concern such as land use, or erosion and sediment. These areas of overlap will be restricted to the water quality effects of nonpoint pollution sources and alternatives for minimizing the problem.

The Water Quality Management Plans being prepared under Section "208" of the Federal Water Pollution Control Act should go a long way toward meeting water quality goals in the region. The magnitude and seriousness of nonpoint pollution sources should be more clearly understood after completion of the plans. Measures to alleviate nonpoint problems will follow the evaluation of problem extent.

6.3H Recreation

Recreational planning in Massachusetts is guided by the Statewide Comprehensive Outdoor Recreation Plan (SCORP) which projects demand figures to

the year 2000. Supply figures, however, are based upon currently available facilities. Comparison of 1990 demand figures with present supply indicates an unmet demand in hiking, camping, and picnicking. Alternatives will be presented in a later chapter which offer potential to meet some, but not all of the projected needs.

Of the 55 natural areas in the Central Region identified by the 1974 Massachusetts Landscape and Natural Areas Survey, 32 are now owned by public or private conservation organizations or institutions. By 1990, it is expected that an additional four sites will be acquired or protected, bringing the number of protected sites to 36.

Historical and cultural sites in the region are more than adequately identified and protected by ongoing efforts of federal, state, and local governments and private individuals and organizations.

Streams in the Central Region do not appear to meet the criteria of the Federal National Wild and Scenic Rivers Act of 1968. The 1976 SCORP report indicated that 10 rivers have potential for protection under the Massachusetts Scenic and Recreational Rivers Act. Because of uncertainty about implementation of the program, we have assumed that no rivers will be protected under the act for the "future-without-plan" condition.

Public access to ponds and lakes in the region should be increasing in the future, although the magnitude of this increase is difficult to quantify. Conservation commissions are actively seeking to acquire prime areas, many of which are wetlands or include fresh open water. Appendix A. indicates the access status of public lakes, ponds and reservoirs. The Massachusetts Public Access Board has proposed the following additional public access sites in the region: Webster Lake, Webster; Bare Hill Pond, Harvard; Lake Quinsigamond, Worcester; North Pond, Hopkinton; Long Sought For Pond, Westford; and Forge Pond, Westford.

<u>6.3I Fish and Wildlife</u>

According to the Division of Fisheries and Wildlife, demand for fish and wildlife recreational opportunities over the next 25 years will increase but to an unknown degree dependent upon various positive and negative factors which are impossible to predict. Participation in hunting and fishing, however, is expected to increase at an average rate of one-half percent per year. Participation in nonconsumptive fish and wildlife recreational activities will likely increase under the stimulus of a state "non-game" program when such is established, and continued publicity involving rare and endangered species.

It is anticipated that the larger game mammals, waterfowl, raptors, upland game, and songbirds will continue to receive major public attention and support. Reptiles, amphibians, rodents, various less visible species, and those animals viewed as pests are expected to attract only minor attention.

NOTES

1/ It should be pointed out that the historical land use data in Chapter 5 are not comparable to the projected land use figures. The reason for this is that Chapter 5 data are based upon W. P. MacConnell's Map Down Project whereas the projections are based upon agricultural census data. The latter source of data utilizes a much more restrictive definition as to what is defined as a farm (a productive unit with some minimum amount of sales), thus the acreage is less than that in the Map Down interpretation.

2/ Agricultural Preservation Act, Massachusetts General Laws, Chapter 780 of the Acts of 1977.

3/ Kingsley, Neal P., The Timber Resources of Southern New England, USDA, Forest Service, Resource Bulletin NE-36, 1974.

4/ Massachusetts Department of Environmental Management, Massachusetts Outdoors Statewide Comprehensive Outdoor Recreation Plan, 1976.

5/ Wetlands Protection Act - Massachusetts General Laws, Chapter 131, Section 40 of the Acts of 1965 as amended.

6/ Massachusetts Executive Office of Environmental Affairs, Massachusetts Water Supply Policy Study, January 1977, Boston, Massachusetts.

CHAPTER 7

NEEDS

7.1 INTRODUCTION

Needs may be defined as the unmet demand which will not be satisfied by existing resource management, or by implementation of authorized plans or projects. The quantification of needs stems from the evaluation of resource capabilities and expected conditions without a plan. In effect, needs indicate the areas where additional planning, authorization, and implementation is needed to meet the desires of society.

7.2 LAND USE NEEDS

7.2A Agricultural Land

Table 7.1 summarizes the needs as determined from the future-without-plan condition relative to the stated problems and objectives. The primary need is to maintain or increase agricultural land. As Table 7.1 also shows, there are a number of subneeds that must be met in order for the primary need to be satisfied.

An interesting aspect within the land resource area is that, by solving the NED problem, much of the identified EQ problem (loss of open land) is also solved. Thus, the needs for the EQ objective in the land resource area are similar to those of the NED objective. There is some dichotomy, however, in that one of the objectives is to increase or, at least, maintain agricultural production. But if this is accomplished, the water resource quality may be adversely effected by continuing or increasing levels of nonpoint sources of pollution. Thus, as Table 7.1 summarizes, there is a need for an aesthetically pleasing land use mix, and if such a mix is derived from a continuation of agriculture, then there is another need to minimize nonpoint sources of pollution from agriculture.

One of the most important regional needs is to complete the soil survey. These surveys are extremely useful in providing an inventory of soil types, in providing soil interpretations for guiding land uses, and in providing critical area locations.

TABLE 7.1 AGRICULTURAL LAND USE NEEDS

Primary Objectives	Resource Area	Needs
NED	Agricultural Land	1. Reverse trend of agricultural land loss. 2. Insure proper land use planning to minimize future development on agricultural land. 3. Complete soil surveys.
EQ	Open Land	1. Locate future developments so as to minimize locations on environmentally sensitive areas. 2. Complete soil surveys. 3. Preserve open land to contribute to an aesthetically pleasing land use mix. 4. Minimize nonpoint pollution agricultural sources.

7.2B Forest Land

By the year 1990, there will be a need for an additional 3.6 million cubic feet of wood products for the region. Forest land needs are summarized in Table 7.2.

The first step in increasing production is to utilize and increase the management on public and private forest land for wood products. There will also be a need to increase the acreage of forest land utilization and management for wood products.

Many landowners require incentives to persuade them to manage and not develop their land for other uses. If landowners are to manage this land for forest products, they must see the possibility of selling the products. There is a need to develop diversified markets. To increase management on private forest land, many owners need to be informed of the opportunities and benefits of forest management.

Additional needs beyond the scope of the material included in this report are areas of study and measures that would complement and strengthen the forest industries. At the present time, the secondary wood-using industries reportedly draw much of their requirements for wood products from areas outside the state. There is a need to study the structure of these industries with a goal of supplying more of their needs from in-state milling plants. The primary processors would thus act more as an import substitution industry.

To increase or maintain the environmental quality of the area, there is a need to combine the urban and forest environments in a way that maintains some of the benefits of the forest environment. This can be accomplished by first informing towns about urban forest management, and, secondly, providing technical assistance to towns to manage their urban forest lands.

TABLE 7.2 FOREST LAND NEEDS

National Objective	Resource Needs	Needs	
		1980 3.0 Million Cubic Feet	1990 3.6 Million Cubic Feet
NED	Forest land	Increase the management of public and private land for wood products from the present 133,000 acres to 372,000 acres.	
		Increase incentives to landowners to manage their forest land.	
		Develop diversified markets for wood products.	
		Inform and educate landowners on the values of forest management.	
EQ	Forest land	Information and education program on forest land.	
		Provide technical services on forest land management.	

MASS. DEPT. OF ENVIRONMENTAL MGT. PHOTO

7.3 FLOODING

One of the objectives of this study of flooding is to develop alternatives to reduce flood damages to an acceptable level. The definition of "acceptable level" is subject to discussion. For purposes of this study, however, average annual flood damage of less than $5,000 was considered an acceptable level. This is roughly equivalent to a 100-year frequency flood causing $80,000 in damage. Subwatersheds needing alternatives to reduce flood damage are indicated in Table 7.3. The North Nashua River subwatersheds (NA-2, 3, and 4) have not been included, since detailed investigations are now underway by the Corps of Engineers.

TABLE 7.3 FLOOD DAMAGE REDUCTION NEEDS

Subwatershed	Description	Average Annual Damage 1/
ME-15	Merrimack River 2/	$ 68,700
ME-19	Shawsheen River	74,500
CO-17	Concord River	48,300
AS-17	Assabet River	6,800
BL-61	Ramshorn Brook	17,100
BL-63	Quinsigamond River	21,800
BL-64	Blackstone River	57,500
BL-65	Mumford River	124,000
TH-1A	Quinebaug River	50,600
SU-16	Baiting Brook	23,500
SU-17	Sudbury River	342,400
NA-7	Nashua River	12,100
NA-8	Catacoonamaug Brook	6,900
NA-10	Squannacook River	13,700
NA-11	Nashua River	16,900

1/ Price Base 1977.
2/ Does not include main stem damages.

7.4 EROSION AND SEDIMENT

Major erosion and sediment control needs are generally limited to construction projects, about 2,500 acres of tilled cropland, and other critical erosion areas, such as streambanks, roads, etc.

7.4A Areas Undergoing Urban Development (construction sites)

From 1952 to 1972, approximately 6,400 acres per year of nonurban land were converted to urban use. During the construction period, soils are usually stripped of vegetative cover and are often left in this exposed condition for extended periods of time. The result can be severe erosion on the site and quantities of sediment released downstream. It is expected that 6,400 acres per year will be converted to urban use by 1990. Gross erosion from these areas is expected to exceed 250,000 tons per year.

7.4B Tilled Cropland

Erosion rates on approximately 20 percent of the tilled cropland exceeds the average annual tolerable soil loss of 3 tons per acre established for most region soils. The tolerable soil loss is an estimate by soil scientists of the maximum allowable soil loss on agricultural land if productivity is to be maintained over time. There are also individual farms within the region which have critical erosion problems, a few exceed the average erosion rate by more than ten times. Cropland treatment needs are good management and the use of good practices such as residue and cover, sod in rotation, contouring, strip cropping, and permanent cover. About 2,500 acres will require sound management and treatment by one or more of the preceeding practices. Some of this acreage will require a return to a permanent vegetative cover to effectively control further erosion.

7.4C Critical Erosion Areas

In addition to these problem erosion areas, the region has some isolated critical erosion areas which are not being stabilized by existing programs. These critical areas include road cuts with unstable slopes, blowing sand from utility rights-of-way which have been scarred by off-road recreational vehicles, and blowing dust from gravel pits. Although these critical areas are not regionally significant in terms of total volume of erosion, the erosion and its effects are locally significant and should be minimized.

7.4D Streambanks

Streambank erosion, although not the major erosion source in terms of total erosion, is, however, a major problem from the standpoint of sediment delivered to watercourses. The 139-miles of major streams and

168 miles of tributaries which are considered to be susceptible to erosion have an annual erosion of 105,000 tons. There is a need to establish vegetative buffer zones along streams where erosion is occurring, and structurally stabilize the most critical areas where vegetative methods are not adequate.

7.5 WETLANDS

According to the wetlands projections in Chapter 6, by the year 1990, over 4,500 acres of inland wetlands will be lost to urban development. An additional 27,000 acres will be protected only by General Laws, Chapter 131, Section 40, the Inland Wetlands Protection Act.

The needs in the area of inland wetlands can be summarized as follows:

1. reduce projected wetland loss;

2. provide additional protection to the 48,200-acres of inland wetlands which are not protected by public ownership or the Inland Wetlands Restriction Act;

3. provide additional public access to inland wetlands for passive recreation.

7.6 WATER SUPPLY

Projections in Chapter 6 indicate 29 towns will have a public water deficiency by 1990. To alleviate this problem, there is a need to: (1) promote conservation of water to include reduction of excessive leakage in existing distribution systems, controlling demand and protection of quality of existing water supplies, (2) locate additional ground water sources, and (3) utilize, or at least preserve, available surface water storage sites.

7.7 WATER QUALITY

Much is being done to alleviate the water quality problems associated with point sources of pollution. However, there is a need to reduce nonpoint pollution sources from sediment, individual septic systems, and other nonpoint pollution sources. Detailed soil surveys are needed on at least 10 towns where significant population growth is expected. Soil information is needed to effectively plan residential development to minimize onsite sewage disposal problems and the resultant effects on water quality.

7.8 RECREATION

Recreation needs as indicated in Table 7.4 shows a surplus in the region of swimming, canoeing, and sailing facilities. However, local areas may be in need of these facilities, as their distribution does not always coincide with population.

TABLE 7.4 RECREATION NEEDS

Activity	1975 Supply (1000 Activity Days)	1990 Demand (1000 Activity Days)	1990 Need	1990 Facilities Needed Number	1990 Facilities Needed Unit
Swimming	10,951	10,447	(surplus)	-	-
Camping	363	427	64	307	sites
Picnicking	1,061	5,038	3,977	10,350	tables
Canoeing-Sailing	1,943	1,715	(surplus)	-	-
Hiking	860	3,270	2,410	900	miles

The needs figures require some explanation. These figures indicate that the Central Region is in a relatively good position in recreation, except for picnicking and hiking. However, the region borders the Boston Metropolitan area which is deficient in all five categories of recreation analyzed; also the demand for picnic facilities is now, and will continue to be, met by informal picnic sites, i.e., a blanket under a tree.

Likewise, a portion of the need for hiking trails may be met with something less than a formally mapped and labeled "trail." Utility rights-of-way, rural highways, and even city streets in an historical area, such as the Central Region, can serve to provide an enjoyable hiking experience.

There is also a need to meet the environmental quality objectives associated with recreation:

1. Outstanding natural areas need to be preserved.

2. Massachusetts Scenic and Recreational Rivers Act should be implemented within the region.

3. Five major rivers should have greenbelts or environmental corridors established. The Merrimack, the Concord along with its two major tributaries, the Assabet and the Sudbury; the Blackstone, and the Quinebaug Rivers should establish a program similar to the Nashua River greenway.

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CHAPTER 8

ALTERNATIVES

8.1 INTRODUCTION

Alternatives designed to meet the needs expressed in Chapter 7 are presented in this chapter for each major study concern. Table 8.4 compares the alternatives with needs, and assesses the effectiveness of each alternative. Effects of the alternatives on national economic development, environmental quality, social well-being, and regional development are presented in Table 8.5. Table 8.6 summarizes the potential environmental effects of the alternatives.

8.2 LAND USE ALTERNATIVES

This section addresses the public policy alternatives that are relevant to the problems and needs identified in land use. One alternative is the continuation of present policies. Since such action would not have a positive impact on the problems and needs discussed in this report, the "without-plan" alternative is omitted from further discussion.

8.2A Agricultural Land Use Alternatives

It is apparent, from recent discussions with state officials, that there is an overriding concern to preserve or expand agricultural land in the hope that production in the agricultural sector may be maintained or increased. Related to this is the desire to maintain an attractive variety of land uses which will continue to provide a good aesthetic and environmental setting, in terms of wildlife habitat and scenic viewing.

Past measures enacted in most states, including Massachusetts, were based upon regulations (i.e., zoning ordinances) and incentives (i.e. agricultural assessments). It is apparent from the continuing loss of farmland that these approaches have not been effective. Regulations have been ineffective for two reasons: (1) Zoning an area "agricultural" does not necessarily guarantee that agriculture will be practical. (2) Those owners whose land is zoned "low density" have a strong economic incentive to press for zoning variances. Historically, not only in Massachusetts, but in almost all states with zoning ordinances, applications for zoning variances are often approved.

The incentive or agricultural assessment approach was aimed at decreasing taxes to agricultural firms. Although this measure has made staying in agriculture easier, it has not precluded the selling of agricultural land to nonagricultural users, primarily because the tax penalties assessed on such transactions are small in comparison to the amounts received for those properties. Little, if any, research has been undertaken to determine exactly how much monetary assistance is required. An underlying thought in the preferential assessment approach is that only a limited assistance is necessary to keep agricultural firms viable.

A number of states have recently been considering other means by which agricultural land might be preserved. Vermont and Washington have enacted land sales excise taxes. In Washington, for example, no taxes are paid on land owned for 6 years or more, and then sold. However, for land owned for less than 1 year, and then sold, the tax amounts to 50 percent of the sales price. Vermont law is similar, though tax percentages may differ somewhat. The main purpose of these laws is to decrease speculative buying of agricultural land with the intent to sell quickly to nonagricultural uses.

A number of states, including Massachusetts, have passed legislation providing for the public purchase of development rights to agricultural land. Such a program is a combination of the regulatory and incentive approaches. It is regulatory, in the sense that agricultural areas must be designated for preservation, and it includes incentives, since the income derived from the buying of the development rights can be reinvested in the farm enterprise to increase efficiency and net borrowing power and, thereby, hopefully increase its competitiveness.

The public investment required in a development rights program is dependent upon the difference in the value of land used for agriculture and the value, if the land were used for development. Thus, areas in close proximity to higher value uses where demand is great would cost the public more per acre to purchase the development rights than areas located further away where the demand is less. After the development rights are purchased, no other uses would be permitted. Such a program has two advantages over those previously mentioned:

1. The sale of development rights will provide compensation to owners of restricted areas.

2. Prospective farmers will require less financial resources to enter farming, since land prices will be based more on the agricultural income potential than upon potential development values.

Table 8.1 summarizes the component needs of agricultural land and the various alternatives through which such needs may be satisfied.

TABLE 8.1 SYSTEMS FOR PRESERVING AGRICULTURAL LAND

Component Needs	A Zoning and Preferential Assessment	B Purchase Leaseback	C Development Rights	D Allotments
1. Maintain or increase agricultural production.	No	Yes	Yes	Yes
2. Maintain or increase environmental and aesthetic qualities.	No	Yes	Yes	Yes

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8.2B Forest Land

Chapter 7 listed both the NED and EQ needs of the forest resource. Based on these needs, four alternatives are presented. Each of these alternatives have specific activities which, when combined, make up the major alternative. One or all of these activities could be implemented. The alternatives and accompanying activities are:

1. Increase management of public and private land by increasing the number of personnel working on state land, and personnel providing technical assistance to private landowners.

    a. Add one technician to work with service forester on CFM.

    b. Add four foresters to provide management assistance to private landowners.

    c. Add two technicians and 14 woods workers to work on state forest land.

    d. Engage professional forestry consultant firms to accomplish the assistance where applicable.

2. Increase incentives to landowners to encourage them to utilize and manage their forest land for timber products.

    a. Increase Forest Incentive Program funding by $62,000.

    b. Change Chapter 61 of the Massachusetts General Laws (Classification and Taxation of Forest Land) by eliminating the ceiling of $400/acre value on forest land.

    c. Increase Agricultural Stabilization and Conservation funds in counties where land is valued too high for Forest Incentive Program funds.

    d. Change liability law to limit landowners' liability for injuries incurred in timber harvesting.

    e. Revise nursery program to provide free trees to landowners.

3. Establish a program to increase and diversify the markets for forest products, to encourage the utilization of low quality products, and to provide increased marketing assistance to the existing wood-using industry.

    a. Hire utilization foresters to work in the area at the county level.

b. Encourage the establishment of plants to utilize low quality products.

c. Develop a fuel wood management program.

d. Provide low interest loans for sawmill modernization.

4. Establish an information and education program to inform private landowners about the benefits of forest land management.

    a. Hire two people to conduct an information and education program throughout the region.

The EQ needs listed in Chapter 7 can also be met with the above alternatives. The information and education program can inform urban as well as rural landowners. The increases in personnel can provide technical assistance needed in the urban areas.

8.3 FLOODING ALTERNATIVES

Flood damages can be minimized by careful planning and implementation of flood plain management techniques. Flood plain management programs should contain regulatory and corrective measures.

8.3A Regulatory Measures

Regulatory measures do not prevent flooding but, instead, reduce the threat of damage or loss of life from floods by discouraging development on flood plains. Regulatory measures include flood plain regulations, development policies, land use restrictions, greenbelts or open space, and flood insurance. Tax adjustments and warning signs are related measures.

In order to limit flooding damage to existing properties in the flood plain, Flood Plain Management Programs should be established for each of the following study areas: Merrimack, SuAsCo, Nashua, Blackstone, and Thames. Flood plain restrictions on the Nashua River are presently being considered under Chapter 131, Sec. 40A (The Inland Wetlands Restriction Act), a program to impose restrictions on selected flood plains. The National Flood Insurance Program, established on a community-by-community basis, would be a major element of any flood plain management program. All communities in the region should cooperate with the National Flood Insurance Program regulations and formulate effective flood plain restrictions, such as zoning and subdivision control.

The first flooding alternative would be to recommend that Ashby, Brimfield, and Dunstable join the National Flood Insurance Program as a first step towards establishing sound flood plain management programs.

8.3B Corrective Measures

Corrective measures, will not eliminate flooding, but can reduce the extent of flooding and resulting damages. These corrective measures are usually physical measures and can include land treatment, floodwater retarding structures, stream modifications, levees or floodwalls, existing reservoir management programs, floodproofing of structures, relocation, acquisition, flood plain reclamation, and flood watch and warning systems.

As noted previously, regulation of development on flood plains is expected to effectively limit increases in flood damages. Corrective measures will also be needed to reduce damage to existing development.

Corrective measures, as described below, are usually physical measures that are designed to reduce or control floods and flood damage.

Land Treatment -- Vegetative and mechanical land treatment measures can be installed on the uplands to prevent destruction of land by erosion and reduce the movement of damaging amounts of sediment to the streams and flood plains. Agricultural lands and lands in transition from agriculture to urban uses should be protected or maintained by temporary vegetation, mulch, sediment basins, or other measures to reduce and control erosion. Land treatment measures also slow or reduce runoff and peak flood flows from upland areas.

Floodwater Retarding Structures -- These structures are earthfill or concrete impoundments that check the uncontrolled flow of floodwater rushing downstream. The structures are located to protect the largest possible area of land subject to flooding, encroach as little as possible on high value lands, and provide a high level of protection to downstream property.

Stream Modifications -- Stream channel changes to increase channel capacity to carry floodwater can be made by straightening, deepening, widening, clearing, or by lining the channel so that flooding will be less frequent and severe.

Dikes and Floodwalls -- These are earth embankments or concrete walls built along the bank of a stream to confine flood flows to the channel or floodway. Dikes and floodwalls are normally used to provide protection to high value flood prone areas.

Floodproofing of Buildings -- Techniques used to make existing buildings, contents, and grounds located in flood hazard areas less vulnerable to flood damage are:

1. permanent measures built as an integral part of the structure, such as: raising the elevation of the structure, waterproofing of basement and foundation walls, anchorage and reinforcement of floors and walls, and use of water-resistant materials;

2. contingency measures which require action to be taken to make them effective, such as, manually closed sewer valves and removable bulkheads;

3. emergency measures carried out during floods according to prior emergency plans, such as sandbagging, pumping, and removal of contents to flood-free areas.

Flood Plain Reclamation -- This includes the permanent evacuation of developed areas subject to inundation and the acquisition of lands by purchase, the removal of structures, and the relocation of the population from such areas. Such lands could then be returned to a natural wildlife habitat or used for agriculture, low intensity recreation, or other purposes which would not interfere with flood flows.

Flood Watch and Warning Systems -- The National Weather Service of the National Oceanic and Atmospheric Administration issues warnings of potential flood producing storms. Frequently, the flood warnings are preceded by a "severe weather or flood watch."

Local programs can also be implemented to give advance warning to flood prone areas of potential or impending flood danger. On small watersheds with considerable swamp storage, staff gages set at key locations could be monitored by local personnel under the Water Watch Program. Monitoring could be accomplished by the use of float-activated electronic warning signals connected to the police or fire department. All warning systems should be coordinated with local Civil Defense disaster plans.

8.3C Evaluated Alternatives

Three combinations of corrective measures were investigated to illustrate the range of possibilities available to reduce existing flood damage. These combinations are presented as flooding alternatives. A summary of the combinations, costs, and remaining damages is presented in Table 8.2.

Land treatment, floodwater retarding structures, stream improvements, and dikes and floodwalls were considered as one combination. These structural measures have been the traditional basis of federally-financed, flood control projects. Reduction in flood damage is achieved by reducing runoff and peak flows, or by confining flood flows to established channels or floodways.

TABLE 8.2

SUMMARY OF ALTERNATIVES TO REDUCE FLOOD DAMAGE
(Thousands of Dollars)

Sub-watershed	1990 Flood Damage		Structural Alternative					Floodproofing Alternative					"Mixed Alternative"				
			Flood Damage with Project		Project Cost 1/		Project Benefits	Flood Damage with Project		Project Cost 1/		Project Benefits	Flood Damage with Project		Project Cost 1/		Project Benefits
	100-Year Flood	Average Annual	100-Year Flood	Average Annual	Total Cost	Average Annual 2/	Average Annual	100-Year Flood	Average Annual	Total Cost	Average Annual 2/	Average Annual	100-Year Flood	Average Annual	Total Cost	Average Annual 2/	Average Annual
ME-15	1,144.3	68.7	868.3	52.1	95.0	6.6	16.6	274.9	16.5	362.0	30.3	52.2	142.6	8.6	387.0	28.6	60.1
ME-19	1,242.0	74.5	707.3	42.4	280.0	19.3	32.1	228.3	13.7	251.0	21.0	60.8	166.2	10.0	405.0	30.0	64.5
CO-17	804.0	48.3	713.0	42.8	50.0	3.5	5.5	176.2	10.6	244.5	20.5	37.7	148.2	8.9	274.5	20.2	39.4
AS-17	112.7	6.8	APPROVED PL-566 PROJECT CONSTRUCTION NEARLY COMPLETED - NO REASONABLY FEASIBLE NONSTRUCTURAL OR MIXED ALTERNATIVE.														
BL-61	285.2	17.1	137.8	8.3	1,820.3	20.7	8.8	53.5	3.2	106.3	8.9	13.9	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
BL-63	363.4	21.8	301.3	18.1	144.0	9.9	3.7	193.2	11.6	95.4	8.0	10.2	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
BL-64	958.0	57.5	699.2	42.0	225.0	15.5	15.5	354.2	21.3	27.5	2.4	36.2	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
BL-65	2,066.0	124.0	DETAILED INVESTIGATIONS NOW BEING CONDUCTED BY THE CORPS OF ENGINEERS.														
TH-1A	844.1	50.6	533.6	32.0	52.6	4.5	18.6	461.2	27.7	90.6	7.6	22.9	150.7	9.0	143.2	11.3	41.5
SU-16	114.8	23.5	DETAILED INVESTIGATIONS NOW BEING CONDUCTED BY THE SOIL CONSERVATION SERVICE.														
SU-17	5,707.3	342.4	1,076.3	64.6	288.0	19.8	277.8	415.8	24.9	280.0	23.5	317.5	314.3	18.9	293.0	21.6	323.5
NA-2,3, & 4	DETAILED INVESTIGATIONS NOW BEING CONDUCTED BY CORPS OF ENGINEERS																
NA-7	201.3	12.1	40.3	2.4	8,058.1	555.1	9.7	25.3	1.5	34.7	2.9	10.6	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
NA-8	115.0	6.9	27.6	1.7	8,853.6	609.9	5.2	32.2	1.9	4.9	.4	5.0	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
NA-10	227.7	13.7	103.5	6.2	90.0	6.2	7.5	39.5	2.4	59.6	5.0	11.3	NO REASONABLY FEASIBLE MIXED ALTERNATIVE.				
NA-11	281.7	16.9	51.8	3.1	517.5	38.3	13.8	121.1	7.6	44.2	3.7	9.3	40.8	2.4	544.8	40.2	14.5

1/ Price Base 1977.
2/ Amortized at 6 3/8 percent for 100 years.

Another combination investigated was a floodproofing program to modify existing damageable property. A wide range of techniques was considered to reduce damage at individual locations. Permanent measures, such as the waterproofing of walls, were combined with contingency measures, such as removable flood barriers to safeguard interior areas from floodwaters. Emergency measures to be carried out during floods, such as pumping and removal of damageable material to flood-free areas, were also included in this alternative.

A third plan included the same structural measures, but combined them with floodproofing. Land treatment, floodwater retarding structures, dikes and floodwalls were used to reduce and control flood flows to manageable levels. Floodproofing measures were then utilized to reduce damage remaining from the reduced flows.

A large part of the damageable property in the region is not suited to economical floodproofing. Much of the road and bridge damage can only be reduced by reducing flood flows or enlarging the bridge. In other instances, floodproofing can create a potentially dangerous situation by giving residents a false sense of security. Residents may choose to remain in their floodproofed homes, when the more prudent action may be to evacuate to higher ground.

By utilizing floodproofing, in combination with structural measurements, it is often possible to reduce the cost and scope of a structural program while increasing the degree of protection afforded to the area.

Detailed investigations and analyses would be required to establish the most acceptable and effective combination of measures to reduce flood damages in the region. The three combinations considered in this study illustrate a range of possiblities. Final selection of a plan would require significant local inputs, consideration of environmental impacts, and a cooperative effort by local, state, and federal agencies.

8.4 SEDIMENT AND EROSION ALTERNATIVES

8.4A Construction Areas

Provisions should be made for the retention of optimum amounts of vegetative cover for watershed protection on all areas undergoing residential, highway, and industrial development and construction. Developers should prepare and follow plans designed to minimize the disruption of the hydrologic balance and the resulting erosion, by maintenance of vegetative cover during construction. Contractors should utilize the natural landscape in their planning for environmental purposes. Where needed, developers and contractors should apply erosion control measures, such as temporary debris basins or desilting basins, seed and mulch exposed areas, create temporary diversions, and retain forest buffer zones during construction. Adequate planning prior to construction and close supervision of construction activities are needed to control erosion.

Naturally, some developers will be reluctant to utilize erosion control measures, unless they can see some financial, aesthetic, or other tangible results. Consequently, we feel that sediment and erosion control ordinances and bylaws are needed to ensure compliance with good conservation practices during construction. These ordinances could be additions to present zoning, subdivision regulations, and/or building regulations.

8.4B Streambank Erosion

Much of the streambank erosion in the region is aggravated by development or activity which occurs too close to the streambank, destroying vegetation and mechanically moving bank material into the stream. In order to protect streams from this erosion pollution danger, we recommend the establishment and maintenance of stream buffer zones within 50 feet of the rivers and streams of the region. These zones should be maintained in forest or other permanent vegetative cover. In many cases, this buffer strip will not completely stabilize the streambank, and structural measures such as rock riprap may be necessary. Vegetative means if not completely successful in stabilizing streambanks, will reduce the problem significantly.

8.4C Tilled Cropland

The Conservation Operations Program of the Soil Conservation Service can assist landowners in applying conservation measures to prevent erosion on cropland. This technical assistance is coordinated through the conservation district and, in many instances, landowners can obtain cost sharing for installation of practices from the Agricultural Stabilization and Conservation Service.

Fiscal and personnel limitations make it necessary to establish priorities for technical and financial assistance. Priorities for technical assistance are provided by the conservation district board of supervisors in each county. Financial cost sharing program priorities are established by the Agricultural Stabilization and Conservation Service County Committee.

Since the installation of conservation practices is a purely voluntary effort on the part of landowners, priorities have tended to favor those farm operators who exhibit the most initiative and desire to install practices. The majority of technical assistance work is precipitated by landowner requests. This procedure has resulted in a good deal of assistance being provided to operators who are already highly motivated to install practices and who are aware of the benefits to be obtained from soil conservation efforts.

As a result of priority procedures and limitations on personnel and funding, many of the farms with severe erosion problems have not received much encouragement to install practices to alleviate the situation. However, these are the very operators who require the most encouragement, assistance, and continued follow-up, if they are to reduce erosion losses.

Cost sharing for conservation practices has favored production-oriented measures rather than erosion control practices. Naturally, the practices which are aimed toward increased production and increased farm income are popular with farmer-recipients. Erosion control practices which may result in a decrease in production tend to be less popular, though no less necessary.

If erosion losses on tilled cropland are to be reduced to acceptable levels, more emphasis will need to be placed on locating, contacting, encouraging, and assisting the farmers with the most severe problems. Since it appears unlikely that significant increases in funding or personnel levels will be forthcoming, other technical assistance and cost sharing measures will need to receive reduced emphasis.

A first step in reducing cropland erosion losses should involve a detailed cropland inventory to assess erosion losses and determine needed treatment for each farm in the conservation district. Priorities for assistance could then be established. SCS technicians should have definite annual goals to contact and assist high priority farm owners. Cost sharing assistance for erosion control practices on priority farms should be allocated the maximum possible funding; even if this acts to the detriment of some of the more popular production-oriented measures presently cost shared.

8.5 WETLANDS

In order to reduce projected wetland losses and to provide additional protection to inland wetland areas, this study has developed a hierarchy of protective measures to be pursued. This hierarchy is based upon the degree of protection provided to the wetlands against unwise development. The basic preference list is, as follows:

1. Public and Quasi-public Ownership.
2. Restrictions under Massachusetts General Laws, Chapter 131, Section 40A, the Inland Wetlands Restriction Act.
3. Conservancy Zoning, or other special zoning regulations.
4. Protection under Massachusetts General Laws, Chapter 131, Section 40, the Wetlands Protection Act.

This list of options was then employed to assist in the development of alternatives for additional wetlands protection.

8.5A Public Acquisition

Accelerated acquisition of inland wetlands by state, county, city, and town agencies could be implemented to add to the projected acquisition of 7,700 acres. State agency acquisition of wetlands will continue to utilize existing funds, such as the Inland Fish and Game Fund. In order

to accelerate acquisition, particularly the Wetlands for Wildlife program of the Massachusetts Division of Fisheries and Wildlife, additional funding from the Massachusetts legislature will be needed.

The Massachusetts Self-Help program should be funded on a regular basis. The U.S. Heritage Conservation and Restriction Service's Land and Water Conservation Fund financing has been increased. A portion of the Self-Help funds and some of Massachusetts' share of the Land and Water Acquisition Fund should be earmarked for wetlands acquisition.

Projections indicate that about 7,700 acres of wetlands will be acquired by 1990 through existing programs. A reasonable goal for additional acquisition is 8,000 acres.

Priority for wetlands acquisition should go to the larger wetlands of the regions. These larger areas offer more potential for wildlife habitat than a like acreage of smaller units. Management of a large area is also likely to be easier than management of several smaller areas. In addition, the large areas offer the potential for lower per-acre acquisition costs as the interior portions of the areas are likely to be without road access and be less valuable real estate.

The 59-wetlands evaluated by the Soil Conservation Service and further described in Chapter 5 are among the largest wetlands in the region. Those with the highest ratings are shown in Table 8.3.

TABLE 8.3 WETLANDS WITH THE HIGHEST RATINGS

	Wetland	Size (acre)	Approximate Percentage Publicly or Quasi-Publicly Owned
M-11,	Bennetts Brook Wetland	142	0
S-2,	Concord River Wetland	1,373	80
S-4,	Hog Swamp	277	0
S-8,	Sudbury River	3,436	50
S-9,	Cedar Swamp	1,583	30
S-11,	Indian Brook Wetland	359	70
N-1,	Nashua River Wetland	467	100
N-12,	Chaffin Pond Wetland	150	0
B-3,	Cider Mill Swamp	238	0
B-7,	Rice City Pond Wetland	105	0
B-8,	Hopedale Pond Wetland	138	70
T-3,	French River Wetland	140	0
T-9,	East Brimfield Reservoir Wetland	654	100

These highest rated wetlands should be considered for early public acquisition.

8.5B Inland Wetlands Restriction Act

Progress in implementing the Restrictions Act has been agonizingly slow. Problems have resulted from the low staffing levels and the complexity of the project. Identification and location of wetland areas have been proceeding at an acceptable rate. The time-consuming procedures involve transfer of wetlands data to assessor's maps, determination of wetland tract ownership, and preparation of legal descriptions of each piece of wetland scheduled for restriction. A significant increase in staff and funding for the Restriction Program is needed, if more rapid results are to be obtained.

8.5C Protective Zoning

Conservancy zones can be a useful tool for the protection of wetlands. Flood plain zones, wetland zones, and conservancy zones usually place significant restrictions on development. Over 20,900 acres of inland wetlands are now in some form of protective conservancy zoning. In some instances, only the major wetlands in a town have been included in the conservancy zone.

Communities are encouraged to establish conservancy zones to protect their inland wetlands from unwise development. Such zoning should be comprehensive and include, as a minimum, all identified wetland areas above 5 acres in size. Communities with partial zoning of wetland areas are encouraged to expand coverage to include all wetland areas of significant size.

8.6 WATER SUPPLY ALTERNATIVES

Appendix A of this report identifies 83 locations which have potential as municipal water supply reservoirs. Topography of the potential storage basin, geology of the abutments and foundation, and land rights costs appear to be favorable.

Information in Appendix A was abstracted from the Inventories of Potential and Existing Upstream Reservoir Sites prepared by the Soil Conservation Service in cooperation with the Massachusetts Water Resources Commission. Data is based on reconnaissance level investigations, and much more detailed investigations are needed before any of the sites could be developed as a municipal water supply storage.

Communities in need of water supply are encouraged to study the possibilities offered by these potential reservoir sites and to take the necessary acquisition or zoning steps to protect suitable sites from development.

The Water Resources Commission can acquire water impoundment sites to meet the future water resources needs of the Commonwealth as authorized by Chapter 767 of the Acts of 1970, Massachusetts General Laws.

8.7 WATER QUALITY ALTERNATIVES

Nonpoint pollution sources need to be evaluated to determine the magnitude of their effect on water quality. Results of the Section "208" water quality studies being conducted by regional planning agencies should give an indication of the extent of nonpoint pollution problems in the region.

Local communities should place more emphasis on soils limitations when planning for growth. Detailed soil surveys made in region towns indicate severe limitations existing for septic tank systems. Communities adopting or updating local zoning ordinances need detailed soils information to intelligently guide growth to suitable areas. In some cases, the use of large residential lot size, in certain soils, can minimize septic tank-leach field problems which might develop if smaller lot size and greater density of development were permitted. Conversely, smaller lot sizes may require sewage collection systems because of inadequate soils for onsite disposal.

On the basis of projected population increases and the lack of complete municipal sewerage, the following communities should obtain detailed soil surveys from the SCS to aid in guiding growth:

Carlisle	Groton	Lancaster	Marlborough	Upton
Dunstable	Lunenburg	Southborough	Framingham	Uxbridge

8.8 RECREATION

The following NED Alternatives 7-1 thru 7-3 and EQ Alternatives 7-4 thru 7-6 are presented to meet the 1990 recreational needs.

7-1 Camping - Provide an additional 100 campsites at Wells State Park, Sturbridge or at some other campground in the eastern portion of SCORP Region III, Central Highlands. Provide a total of 200 additional campsites, at Lowell-Dracut State Forest, Upton State Forest, and Hopkinton State Park.

7-2 Picnicking - Provide an additional 2,800 picnic tables. This will approximately double the present supply within the region. These tables could be located on state forests and parks, town lands, and also the private sector could contribute towards reducing this need.

7-3 Hiking - Provide hiking trails within proposed greenbelts for the five major rivers. This could add over 100 miles to the state's trail system. Linking trails to the existing Massachusetts Commonwealth Trail System and presently proposed additions to this system should be considered.

7-4 Promote acquisition of the additional natural areas identified in the 1974 Massachusetts Landscape and Natural Areas Survey. It is anticipated that 37 of the 55 natural areas will be adequately protected by 1990 under ongoing programs.

7-5 Implement the Massachusetts Scenic and Recreational Rivers Act within the region.

7-6 Establish greenbelt programs similar to the Nashua River Greenway Program for an additional four rivers in the region - the Merrimack, SuAsCo (Sudbury, Assabet, and Concord Rivers), Blackstone and Quinebaug Rivers.

8.9 COMPARISON OF ALTERNATIVES AND NEEDS

Alternatives and needs were compared for each study concern by national objective. This information is summarized and displayed in Table 8.4.

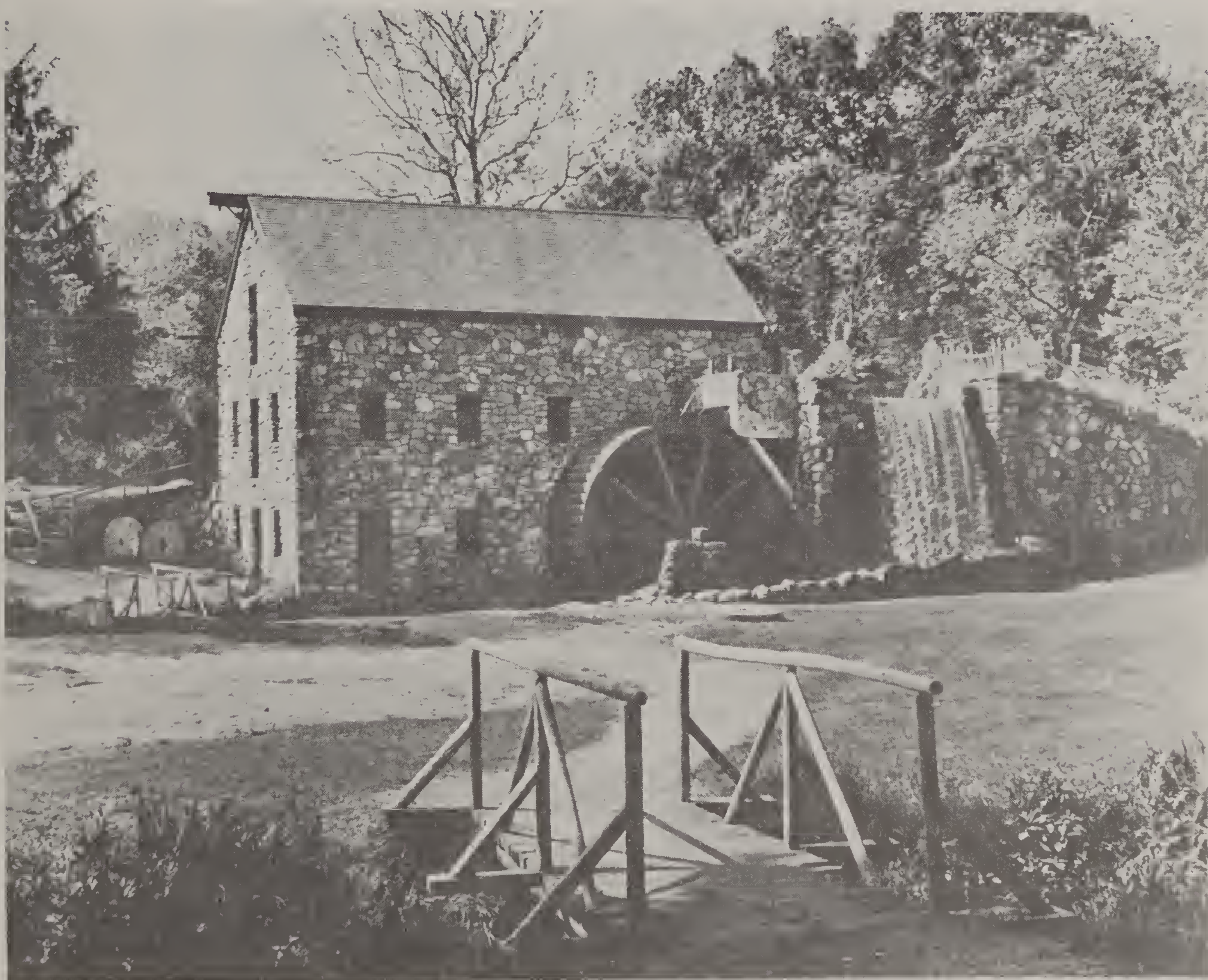

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TABLE 8.4 COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern		Alternatives	Comparison with Needs
NED	Land Use Agricultural Land	1-1	Ignore situation and continue to let market forces operate to the demise of the agricultural sector.	1. Would not generate any positive solution to expressed needs.
		1-2	Undertake a multi-faceted program whereby state and local officials, public and private institutions would actively press for public programs to preserve agricultural land by keeping land in agricultural production.	1. Would directly and indirectly have a positive impact on meeting the expressed need of maintaining or increasing the agricultural base.
			a. Identify sources of comparative disadvantages and develop public policies and programs to minimize the disadvantages wherever possible.	a. Would increase economic viability and thereby contribute to reversing the trend of agricultural land loss.
			b. Complete soil surveys to determine most feasible locations of future developments while prohibiting their location on productive agricultural lands.	b. Would minimize adverse impacts of development upon agriculture and would contribute to EQ needs as well.
			c. Form task force to determine negative impacts of presently enacted and future legislation upon the agriculture sector and revise such legislation to minimize adverse impacts.	c. Would potentially help to minimize the impact of some ordinances (e.g., zoning ordinances) that promulgate specific goals but create incentives which are in opposition to those goals.
			d. Form task force to actively seek public programs to provide incentives for food and fiber processing and marketing firms to locate in the region.	d. Same as a. above.
			e. Form research task force to develop or locate new crops, crop and livestock products, which could be produced in the region and thereby increase diversity of production.	e. Same as a. above.
NED & EQ	Land Use Forest Land	1-3	Increase management of public and private forest land by increasing personnel working on state land, personnel providing technical assistance to private landowners, and by employing professional consulting foresters.	1. Will meet about 45 percent of the 1990 needs for wood products. 2. Increase the acres managed by about 40 percent. 3. Adequately meets the need for technical assistance on urban forest management.

TABLE 8.4 - cont. COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Land Use Forest Land	1-4 Increase incentives to landowners to encourage them to utilize and manage their forest land for timber.	1. Will meet about 43 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 48 percent. 3. Will meet the need for increased incentives in the area.
		1-5 Establish a program to develop diversified markets for forest products.	1. Will meet about 14 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 16 percent. 3. Over a period of time this program will meet nearly all the needs for diversified markets.
NED & EQ	Land Use Forest Land	1-6 Establish an information and education program to inform private landowners about the benefits of forest land management.	1. Will meet about 20 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 22 percent. 3. Adequately meet the needs for knowledge on forest land management. 4. Adequately meets the need for knowledge on urban forest land management.
NED	Flooding	2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program.	1. Limits future development of flood-prone areas and encourages communities to consider flood hazards when planning growth.
		2-2 Implement structural measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, BL-64, TH-1A, SU-17 and NA-10.	1. Reduces average annual flood damage from \$10,927,400 to \$4,701,200.
		2-3 Implement floodproofing measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, BL-61, BL-63, BL-64, TH-1A, SU-17, NA-7, NA-8, NA-10, and NA-11.	1. Reduces average annual flood damage from \$12,174,000 to \$2,375,000.

TABLE 8.4 - cont. COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern		Alternatives	Comparison with Needs
NED	Flooding cont.	2-4	Implement a combination of structural and flood-proofing measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, TH-1A and SU-17.	1. Reduces average annual flood damage from $9,741,700 to $922,000.
EQ	Erosion & Sediment	3-1	Establish erosion and sediment control ordinances in municipalities with the most potential for urban development.	1. Reduces erosion on the 6,400-acres per year undergoing urbanizing development.
		3-2	Establish and maintain stream buffer zones with forest and other permanent vegetative cover, within 50 feet of the region's rivers and streams.	1. Reduces erosion from the area with the greatest potential for stream degradation through sedimentation.
NED	Erosion & Sediment	3-3	Establish program by SCS aimed at eliminating high erosion losses on "problem" farms of region. Inventory conservation measures and follow-up procedure.	1. Reduces high soil losses on 2,500 acres, 20 percent of tilled cropland.
EQ & NED	Wetlands	4-1	Accelerate wetlands acquisition programs to acquire an additional 8,000 acres of regionally important wetlands.	1. Reduces projected wetland loss. 2. Provides public access to inland wetlands for passive recreation.
		4-2	Expand conservancy zoning or other special zoning regulations for wetland areas.	1. Reduces projected wetland losses. 2. Provides additional protection to the 52,800 acres of inland wetlands which are not protected by public ownership, or the Inland Wetland Restriction Act.
EQ	Wetlands	4-3	Accelerate the Inland Wetlands Restriction Program.	1. Reduces projected wetland losses.
NED	Water Supply	5-1	Communities investigate water supply opportunities offered by the 83 reservoir sites identified in Appendix A.	1. Identified reservoir sites have potential to supply nearly 114 million gallons per day of safe yield.

TABLE 8.4 - cont. COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern		Alternatives	Comparison with Needs
NED	Water Supply cont.	5-2	Potential reservoir sites which can meet community water supply needs are acquired or otherwise protected from development which would make them unavailable or prohibitively expensive when needed as water supplies.	1. Reservoirs which have potential to meet a specific community need for water supply will be available when needed.
EQ	Water Quality	6-1	Obtain detailed soil surveys and use them to guide growth in the following communities: Carlisle, Dunstable, Groton, Lunenburg, Lancaster, Southborough, Marlborough, Framingham, Upton, Uxbridge	1. Reduces the potential harmful effects on water quality caused by malfunctioning septic tank systems located in unsuitable soils. 2. Has benefits in the area of land use by directing development away from "sensitive areas." 3. Has benefits in land use (agricultural land) by identifying prime agricultural land and land of state and local importance for farming.
NED	Recreation	7-1	Provide 300 additional campsites within region.	1. Meets 1990 needs.
		7-2	Provide an additional 2,800 picnic tables.	1. Supplies approximately 25 percent of 1990 needs.
		7-3	Provide over 100 miles of hiking trails along major river corridors.	1. Supplies approximately 12 percent of 1990 needs.
EQ	Recreation	7-4	Acquire an additional six natural areas as identified in the 1978 Massachusetts Landscape and Natural Area Survey.	1. Will help maintain region's supply of natural areas.
		7-5	Implement Massachusetts Scenic and Recreational Rivers Act in region.	1. Will help maintain riverine resources.
		7-6	Establish greenbelts (similar to Nashua River Greenway) in four additional major rivers: Merrimack; Concord and its tributaries, Assabet and Sudbury; Blackstone; and Quinebaug Rivers.	1. Same, plus provide recreational use. 2. With improvements in water quality underway, these river corridors will have much greater recreation potential.

8.10 ALTERNATIVE ACCOUNTS DISPLAY

The Water Resources Council's Principles and Standards for Planning of Water and Related Land Resources require that a system of information accounts be established to display beneficial and adverse effects of each alternative proposed to meet an objective. The effects of each alternative on national economic development, environmental quality, regional development, and social well-being are indicated to provide a basis for comparing alternatives. The purpose is to display beneficial and adverse effects so that different levels of achievement of each objective and trade offs between alternatives can be discerned and compared. These beneficial and adverse effects are displayed in Table 8.5.

8.11 POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Each alternative was evaluated to determine what significant environmental impacts, if any, it would have on the region. These findings are displayed in Table 8.6.

SCS PHOTO

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
1-Land Use 1-1 Agricultural Land - continue present land policies.	Beneficial Effects Minimizes public costs relative to preservation programs. Adverse Effects Projected loss of 22,623 acres and net income potential from lost production.1/ Pro-rated cost of administering zoning ordinances. Loss of tax revenue from agricultural-horticultural assessments.	Beneficial Effects Continuing loss of agricultural land will decrease amounts of herbicides, pesticides and fertilizer nutrient entering water resources through runoff. Less erosion and sedimentation resulting from less land being cultivated. Adverse Effects Less diversified land use mix, thus lowering the aesthetic quality of the region. Adverse impact upon wildlife feeding habitat through a decrease in boundary areas of open and forestland.	Adverse Effects Adverse to the extent that loss of agricultural production results in loss of input and output agricultural service and marketing facilities.	Adverse Effects Decrease in agricultural land decreases the aesthetic qualities of the area. Increase in food costs to extent of increased transportation charges for increased food imports.

1/ Approximate agricultural valuations (state averages) were computed by Dr. E. Engle, Department of Food and Resource Economics; University of Massachusetts (1974) for eight categories of agricultural land. Shade tobacco and nurseries: $480-720/acre; binder tobacco, vegetables, potatoes: $150-230/acre; cropland, pasture (tillable: $110-170/acre; orchards: $160-240/acre; cranberry bogs: $560-840/acre; untillable permanent pasture: $40-60/acre; farm woodland: $20-30/acre; nonproductive farm woodland: $5-7/acre.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
1-Land Use - cont. 1-2 Agricultural land - preserve or increase existing quantities of agricultural land.	Beneficial Effects Net earning and subsequent tax revenues that would be lost without preservation. Food cost savings to extent that decrease in food products would be imported from other areas, thus increasing food prices. Preservation would preclude the projected annual loss of agricultural production value (between \$4,064,901 and \$12,383,007, 1967 constant \$).2/ Adverse Effects Costs of preservation measures more expensive than present policies.1/ A. Purchase lease-back program: Initial cost of purchase (\$600-\$3,000 per acre) minus revenues derived from renting to agricultural entrepreneurs. B. Development Rights Program: Cost of Purchasing Development Rights.	Beneficial Effects Benefit would be derived to the extent that preservation of agricultural land would enhance the aesthetic qualities of diversified land use mix. Maintaining agricultural land would preserve boundary areas which would enhance wildlife habitat. Adverse Effects Increases pesticide, herbicide and other residues entering water areas through runoff has a detrimental impact on environmental quality. Increased erosion and sedimentation resulting from cultivating preserved acreage.	Beneficial Effects Benefits accrue to the extent that rates of unemployment and underemployment fall relative to such rates if land were not preserved. Much tourism due to aesthetic qualities which are enhanced through the maintenance of a diversified land use mix. Benefits accrue to the extent that agricultural land enhances the tourist industry. Adverse Effects One potential adverse impact stems from the development that would occur on the preserved acreage without a preservation program and that which would not occur with a preservation program. Although there is enough developable land in the region, even with a Preservation Program, added costs of developing nonpreserved land may result in some firms locating elsewhere.	Beneficial Effects Social well-being is enhanced to the extent that preservation measures enhance the aesthetic qualities of the region. To the extent that preservation measures result in lower food prices than would exist without a Preservation Program, SW-B is increased. Adverse Effects To extent society is adversely effected by noise and smells of agricultural production.

1/ Values of agricultural land in the region are dependent upon provision of roads, water, sewer, electricity and physical characteristics. A purchase lease-back program would involve a \$600-\$3,000 range. Prices that would be relevant for a Development Rights Program would be to determine an acceptable rate of return per acre and from that determining the capital cost of purchasing that land based on an acceptable return and subtracting the capital cost/acre from the market value of the land. This program is further complicated by the fact that, although almost all agricultural land is zoned residential, much land would not be developed due to location of flood plains, wetlands, and/or the physical characteristics of the land itself. Thus, under these circumstances, prices of development rights would be negligible.

2/ Value of lost production computed by multiplying average value of production per acre (expressed in constant 1967 dollars) times the projected range of agricultural acreage decline.

TABLE 8.5- cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use</u> - cont.	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-3 Increase management of public and private forest land by increasing personnel working on state land and personnel providing technical assistance to private landowners, and by employing professional consulting foresters.	Sawtimber-1,600,000 c.f./yr. valued at $829,000 Pulpwood-95,000 c.f./yr. valued at $21,000 Recreation General-83,000 V.D./yr.1/ valued at $166,000 Recreation Special-344,000 V.D./yr. valued at $1,679,000 Water-3,800 A.F. valued at $9,500. <u>Adverse Effects</u> Variable costs-$214,000/yr.	Increase in technical services for urban forest management. Improvement in wildlife habitat by creating a more diverse forest cover. Increased management and protection enhances the benefits provided by forestland. Increase in technical assistance insures the protection of the quality of soil, water and aesthetics. <u>Adverse Effects</u> Possible minor increase in erosion and sediment.	Increase employment by hiring 4 professionals, 3 technicians and 14 woods workers. Increase in cut provides additional wood for presently underutilized mill capacity; provides increase in income to loggers and mills from additional wood; provides increase in revenues from tourism. Increase in industry employment because of increase harvest. Increase in recreational employment because of increase in visitor days.	Increased employment from more state, industry and recreational employment.
1-4 Increase incentives to landowners to encourage them to utilize and manage their forestland for timber.	<u>Beneficial Effects</u> Sawtimber-1,400,000 c.f./yr. valued at $725,000 Pulpwood-700,000 c.f./yr. valued at $155,000 Recreation General-30,000 V.D./yr. valued at $60,000 Recreation Special-130,000 V.D./yr. valued at $634,000 Water-1,800 A.F./yr. valued at $4,500. <u>Adverse Effects</u> Variable Costs-$620,000/yr.	<u>Beneficial Effects</u> Increase in forest management promotes and enhances benefits derived from forest land for now and in the future. More forestland managed decreases loss to urban development.	<u>Beneficial Effects</u> Increases in regional income due to increase timber harvesting and recreation V.D. Enhances future employment because of increased forest productivity.	<u>Beneficial Effects</u> Increases the present and future employment.

1/ V.D. = Visitor Days.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
1-Land Use - cont. 1-5 Establish a program to develop diversified market for forest products.	Beneficial Effects Sawtimber-178,000 c.f./yr. valued at $922,000 Pulpwood- 372,000 c.f./yr valued at $83,000 Recreation Special-112,000 V.D./yr valued at $547,000 Water-10,200 A.F. valued at $25,500. Adverse Effects Variable Costs-$93,000/yr. Implementation Costs-$750,000.	Beneficial Effects Increase in utilization promotes increase in wildlife habitat and provides better forest management practices. Provide market for forest products from land clearing, decreases burning and land fills. Adverse Effects Increases in erosion and sediment minimal.	Beneficial Effects Increase in employment dependent upon plant size. Addition of two professionals to state employment. Adverse Effects Implementation cost of $750,000 by private industry. Annual operating cost of $93,000.	Beneficial Effects Increased employment from industry and state. Increased recreation close to urban centers.
1-6 Establish an information and education program to inform private landowners about the benefits of forestland management.	Beneficial Effects Sawtimber-690,000 c.f./yr. valued at $357,000 Pulpwood-72,000 c.f./yr. valued at $16,000 Recreation General-780,000 V.D./yr. valued at $1,560,000 Recreation Special-409,000 V.D./yr valued at $1,996,000 Water-600 A.F./yr valued at $1,500. Adverse Effects Variable Cost-$36,000/yr.	Beneficial Effects Provide information to urban forest landowners on management opportunities. Urban forestry technical assistance will help make development of forestland more environmental and aesthetically sound.	Beneficial Effects Increase income to area by increasing visitor days, valued at $3,556,000. Increased income from an increase in employment from more recreation and timber harvesting.	Beneficial Effects More aesthetic urban environment Increased employment. Increase in recreational opportunities close to urban centers.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
2-Flooding 2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program. Joining the program entails establishing effective flood plain restrictions; such as, zoning, subdivision controls and building regulations for development within the flood plains.	Beneficial Effects Prevents increases in damageable properties. Adverse Effects $100,000 initial cost of program. $4,000 per year for operation and management of program.	Beneficial or Adverse Effects Renewable resource lands (flood plains) protected as a result of required land use regulations. Tends to maintain existing water quality by preventing building development close to streams. Maintenance of streamsite habitats minimizes hazards to endangered species of animals, fish and plants.	Beneficial Effects Prevents increases in damageable properties. Prices of buildable land may go up, thus increasing property values. Adverse Effects Flood plain land no longer available for residential, commercial or industrial use. Prices of buildable land may go up which may adversely effect industrial and commercial activity. $2,000 per year for regional operation and management costs of program.	Beneficial or Adverse Effects Psychological satisfaction from the action. Program will help maintain present neighborhood character in vicinity of flood hazard areas. Remaining uplands will be subject to accelerated neighborhood change. Present landowners may face loss of property value due to program. Provides an equitable distribution of flood hazard risks.
2-2 Implement structural measures. A program of structural measures is economically feasible in the following subwatersheds: ME-15, ME-19, CO-17, BL-64, TH-1A, SU-17, and NA-10.	Beneficial Effects Average annual flood damage will be reduced by $373,600. Adverse Effects Average annual cost is estimated to be $75,400.1/	Beneficial or Adverse Effects Irreversible commitment of land for program measures. Streams altered for project measures.	Beneficial Effects Developed land no longer subject to flooding from 100-year storm. Average annual damage will be reduced by $373,600. Creates 27 man years semi-skilled employment. Adverse Effects Local average annual cost is estimated to be $8,300.	Beneficial or Adverse Effects Reduce health and safety hazards associated with flooding. Psychological satisfaction from the action. Some landowners may be adverse to the action. Creates 27 man years semi-skilled employment.

1/ Discount estimated evaluation period.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
2-Flooding - cont. 2-3 Implement floodproofing measures. A program of floodproofing existing structures is economically feasible in the following subwatersheds: ME-15, ME-19, CO-17, BL-61, BL-63, BL-64, TH-1A, SU-17, NA-7, NA-8, NA-10, and NA-11.	Beneficial Effects Average annual flood damage will be reduced by $587,600. Adverse Effects Average annual cost is estimated to be $134,000.	Beneficial or Adverse Effects May adversely effect appearance of some existing structures.	Beneficial Effects Average annual damage will be reduced by $587,600. Will create 40 man years semi-skilled employment. Adverse Effects Local average annual cost is estimated to be $120,000.	Beneficial or Adverse Effects Reduces health and safety hazards associated with flooding. Psychological satisfaction from the action. Some landowners may be adverse to the action. Will create 40 man years semi-skilled employment.
2-4 Implement both structural measures and flood proofing. A program combining structural measures with floodproofing is economically feasible in the following subwatersheds: ME-15, ME-19, CO-17, TH-1A, SU-17.	Beneficial Effects Average annual damage will be reduced by $529,000. Adverse Effects Average annual cost is estimated to be $111,700.	Beneficial or Adverse Effects Irreversible or irretrievable commitment of land for program measures. Stream channel altered for project measures. May adversely effect the appearance of some existing structures.	Beneficial Effects Average annual damage will be reduced by $529,000. Developed land no longer subject to flooding from 100-year storm. Will create 37 man year semi-skilled labor. Adverse Effects Local average annual cost is estimated to be $78,200.	Beneficial or Adverse Effects Psychological satisfaction from the action. Some landowners may be adverse to the action. Will create 37 man years semi-skilled labor. Reduces health and safety hazards associated with flooding.
3-Erosion & Sediment 3-1 Establish erosion and sediment control ordinances in municipalities with the most potential for urban development.	Beneficial Effects 18,000 tons/yr. sediment damage reduction. Adverse Effects $55,000 initial capital cost to initiate program. One and one-half man years to manage program.	Beneficial or Adverse Effects Reduce erosion on 6,000 acres/year of construction sites. Eliminate 18,000 tons/yr. of construction site produced sediment. Improvement of water quality downstream.	Beneficial Effects Adverse Effects	Beneficial or Adverse Effects Will increase cost of developing land for urban purposes.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
3-Erosion & Sediment - cont.	Beneficial Effects	Beneficial or Adverse Effects	Beneficial Effects	Beneficial or Adverse Effects
3-2 Establish program by SCS aimed at eliminating high erosion losses on "problem" farms of region. Inventory, conservation measures and follow up procedure.	Productivity of farmland is maintained. $24,000 per year sediment damage reduction. Adverse Effects $20,000/yr. cost of program.	Reduce erosion on 2,500 acres of tilled cropland. Eliminate 4,000 tons/year of sediment from these sources. Improve stream water quality.	Reduce average annual sediment damages by $24,000. Adverse Effects	Create one professional job per year. Psychological satisfaction from the action.
3-3 Establish and maintain stream buffer zones, forest and other permanent vegetative cover within 50 feet of the region's rivers and streams.	Beneficial Effects Action results in slowing down of streambank erosion and subsequent sedimentation. Adverse Effects Annual administration cost of program is estimated to be $2,000. Loss of production on less than 100 acres of agricultural land.	Beneficial or Adverse Effects Reduce erosion on 80 bank miles and thereby reduce subsequent sedimentation. Establish permanent vegetation on approximately 1,000 acres. Maintain permanent vegetation along additional 230 miles of rivers and streams. Improve stream water quality. Improve quality of fish and wildlife habitat.	Beneficial Effects May increase the supply of recreation activity days in the region. Adverse Effects	Beneficial or Adverse Effects Some landowners may be dissatisfied with reduction in cropland acreage. Psychological satisfaction from the action.
4-Wetlands	Beneficial Effects	Beneficial or Adverse Effects	Beneficial Effects	Beneficial or Adverse Effects
4-1 An accelerated acquisition program to acquire an additional 8,000 acres (7,700 acres are expected to be acquired under ongoing programs) of regionally important wetlands.	Will contribute to meeting recreational and educational needs. Tends to maintain recreational quality of 8,000 acres. Adverse Effects Average annual cost is estimated to be $336,000.	Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 8,000 acres prevented. Tends to maintain existing water quality. Tends to maintain low flow regime.	Will contribute to meeting recreational and educational needs of region. Adverse Effects Average annual cost is estimated to be $336,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base. Initial capital cost is estimated to be $5,600,000.	Psychological satisfaction from the action. Some resource owners may be adverse to the action.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
4-Wetlands - cont. 4-2 Accelerate Inland Wetland Restriction Program.	Beneficial Effects Will contribute to meeting recreational needs. Adverse Effects Annual cost is estimated to be $250,000.	Beneficial or Adverse Effects May lead to preservation of environmentally unique and valuable areas. Will tend to preserve existing wildlife habitat. Tends to maintain existing water quality.	Beneficial Effects Adverse Effects Annual cost is estimated to be $250,000.	Beneficial or Adverse Effects Psychological satisfaction from the action. Some resource owners may be adverse to the action.
4-3 Expand special regulations for wetland areas such as, Conservancy Zoning.	Beneficial Effects Discourages improper land use of wetlands.	Beneficial or Adverse Effects Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 4,590 acres prevented. Tends to maintain existing water quality Tends to maintain low flow regime.	Beneficial Effects Adverse Effects Initial capital cost is estimated to be $50,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base.	Beneficial or Adverse Effects Psychological satisfaction from the action. Some resource owners may be adverse to the action.
5-Water Supply 5-1 Investigate potential surface water reservoir sites for use as municipal water supplies.	Beneficial Effects Adverse Effects Cost of investigations.	Beneficial or Adverse Effects	Beneficial Effects More fully evaluates the potential of these reservoir sites.	Beneficial or Adverse Effects Provides community with sound data upon which to base future planning.
5-2 Acquire or otherwise protect suitable potential surface water reservoir sites.	Beneficial Effects Potential reservoir site is available when needed to provide water for economic growth. Adverse Effects Cost of land purchase or easements.	Beneficial or Adverse Effects Present land use is maintained. Future land use may change to open water.	Beneficial Effects Potential reservoir site is available when needed to provide for regional economic growth.	Beneficial or Adverse Effects Assures water supply for future needs.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>6-Water Quality</u> 6-1 Obtain detailed soil surveys and use them to aid in guiding growth in the following communities: Carlisle, Dunstable, Groton, Lunenburg, Lancaster, Southborough, Marlborough, Framingham, Upton, Uxbridge	<u>Beneficial Effects</u> Assists in determining least cost alternatives to solving water quality problems. <u>Adverse Effects</u> Initial cost is estimated to be $150,000.	<u>Beneficial or Adverse Effects</u> Provides tool for maintaining present quality of all water and related land resources.	<u>Beneficial Effects</u> Will create 6 man years employment for a professional soil scientist. <u>Adverse Effects</u> Initial cost to towns within the region is estimated to be $110,000.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Provides basis for determining public health problems associated with water quality.
<u>7-Recreation</u> 7-1 Provide 300 additional campsites within the region.	<u>Beneficial Effects</u> Will provide an additional 69,000 activity days or $138,000 in recreation benefits annually. <u>Adverse Effects</u> Average annual cost including O, M & R of about $105,000. Loss of potential timber harvest on 40 acres of woodland.	<u>Beneficial or Adverse Effects</u> Provides opportunity to modify landscape quality. Creation of 40 acres of camping facilities. Modify 40 acres of forestland by clearing openings for tent sites access and other facilities. May reduce quality of wildlife habitat on approximately 40 acres.	<u>Beneficial Effects</u> Will create 2 permanent semi-skilled jobs. Will create 4 semi-skilled jobs for 1 year. Will create approximately 28,000 activity days or $56,000 in recreation benefits annually to those within the region. May attract recreation oriented firms. <u>Adverse Effects</u> Loss of potential timber harvest on 40 acres of woodland.	<u>Beneficial or Adverse Effects</u> Will provide 69,000 activity days for recreational opportunities. Will create 2.5 permanent semi-skilled jobs. Will create 4 semi-skilled jobs for 1 year. Provides for a more equitable distribution of recreational resources. Will create seasonal population influx. Psychological satisfaction from the action.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
7-Recreation - cont. 7-2 Provide an additional 2,800 picnic tables.	Beneficial Effects Provides an additional 1,000,000 activity days or about $2,000,000 in recreation benefits annually. Adverse Effects Average annual cost including O,M&R of about $980,000.	Beneficial or Adverse Effects Provides opportunity to maintain or increase landscape quality. Creation of 350 acres of picnic facilities. Modifies 350 acres of forest land by clearing for picnic sites. May reduce quality of wildlife habitat on approximately 350 acres.	Beneficial Effects Will create 2 permanent semi-skilled jobs. Will create approximately 406,000 activity days or about $812,000 in recreation benefits annually to those within the region. May attract recreation oriented firms. Adverse Effects Loss of potential timber harvest on 350 acres of woodland.	Beneficial or Adverse Effects Will provide 1,000,000 activity days for recreational opportunities. Will create 14 permanent semi-skilled jobs. Provides for more equitable distribution of recreation resources. Will create seasonal population influx. Psychological satisfaction from the action.
7-3 Provide hiking trails within proposed greenbelts for the 5 major rivers. Approximately 100 miles of trail.	Beneficial Effects Provide passive recreation opportunities. Adverse Effects Costs $500,000.	Beneficial or Adverse Effects Increases management of natural and developed areas for human enjoyment.	Beneficial Effects	Beneficial or Adverse Effects Psychological satisfaction from the action. Some landowners may be adverse to the action.
7-4 Acquire 6 natural areas (as identified by Natural Area Survey) by quasi-public or public agency.	Beneficial Effects Preservation of unique natural areas will help maintain attractiveness of region for tourists and other recreation users. Adverse Effects Annual operation budget for program of $10,000. Costs involved in implementing program.	Beneficial or Adverse Effects Preservation of unique natural areas would be monitored by region residents. This will contribute to preservation of those areas not considered "safe indefinitely."	Beneficial Effects Creates 5 skilled temporary part-time jobs. Economic value to the region of each area would be identified. Maintain attraction of area for tourists and other recreation use. Adverse Effects Recommendations made may preclude commercial, industrial, or residential development in certain areas.	Beneficial or Adverse Effects Action would increase public awareness. Psychological satisfaction from the action. Landowners may be adverse to some recommendations. Create 5 skilled temporary part-time jobs.

TABLE 8.5 - cont. ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
7-Recreation - cont.	Beneficial Effects	Beneficial or Adverse Effects	Beneficial Effects	Beneficial or Adverse Effects
7-5 Implement the Massachusetts Scenic & Recreational Rivers Act within the region.	Positive step in initiating future alternatives of economic significance. Adverse Effects Average annual cost of administering and enforcing the program is estimated to be $3,000.	Maintains present water quality. Insures preservation of stream character. Positive step in initiating future environmental alternatives.	Provides 1 skilled temporary part-time job. Adverse Effects Price of buildable land may go up which may adversely effect industrial and commercial activity.	Psychological satisfaction from the action. Some landowners may be adverse to the action. Provides 1 skilled temporary part-time job.
7-6 Establish greenbelt programs (similar to the Nashua River Greenway Program) on 4 additional rivers: Merrimack, Concord and tributaries; Blackstone, and Quinebaug Rivers.	Beneficial Effects Provides additional activity days of recreation. Prevents increase in flood damageable properties. Adverse Effects Cost incurred to carry out the program.	Beneficial or Adverse Effects Maintains present water quality. Insures preservation of stream character.	Beneficial Effects Provides additional jobs. Adverse Effects Price of buildable land may go up which may adversely effect industrial and commercial activity.	Beneficial or Adverse Effects Psychological satisfaction from the action. Some landowners may be adverse to the action. Provides additional jobs.

TABLE 8.6 POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES

ALTERNATIVES		Erosion & Sedimentation	Water Table Changes	Changes Flow Regime	Changes Land Use	Upland Wild-life Habitat	Bottomland WL Habitat	Bottomland Hardwoods	Stream Fisheries	Wetlands	Rare or Endangered Animals, Plants	Intermittent Streams	Perennial Streams	Water Quantity	Water Quality Incl. Receiving Water	Appearance of the Landscape	Irreversible & Irretrievable Commitment of Resources 2/
		SIGNIFICANT ENVIRONMENTAL IMPACTS ON: 1/															
1.1	Ignore loss of agricultural land	.	.	.	0	-	-	.	0	.	.	.	.	0	0	-	+
1.2	Preserve agricultural land	0	.	.	+	+	+	.	.	.	.	.	.	0	0	+	+
1.3	Increase forest management	0	.	.	.	.	.	+	.	.	.	.	.	0	0	0	+
1.4	Increase forest util. & mgt. incentives	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	+
1.5	Develop markets for forest products	0	.	.	.	.	.	.	.	.	.	.	.	.	.	0	+
1.6	Estab. forestry info & education program	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+
2.1	Participation in Flood Insurance Program	+	.	+	+	.	+	+	+	+	.	.	+	.	+	0	+
2.2	Structural flood protection	0	0	0	0	0	0	0	-	0	.	.	-	0	0	0	-
2.3	Floodproofing and nonstructural	.	.	.	.	.	.	.	.	0	.	.	-	.	0	0	-
2.4	Structural and floodproofing	0	0	0	0	0	0	0	-	0	.	.	-	0	0	0	-
3.1	Erosion & sediment control ordinances	+	.	.	.	+	+	+	+	+	.	+	+	.	+	+	+
3.2	Stream buffer zone	+	0	0	+	.	0	+	+	+	.	.	+	.	+	0	+
3.3	Cropland erosion program	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
4.1	Wetlands acquisition	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+
4.2	Expand wetland zoning	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+
4.3	Accelerate Inland Wetland Restriction Pro.	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+
5.1	Investigate potential water supplies	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	+
5.2	Acquire or protect water supply sites	.	.	.	+	.	.	.	.	.	.	.	.	+	+	+	+
6.1	Complete soil surveys	+	+	.	+	+	+	+	+	+	.	+	+	.	+	+	+
7.1	Provide additional campsites	-	.	.	0	-	-	.	0	.	0	.	.	.	-	+	+
7.2	Provide additional picnic tables	-	.	.	0	-	-	.	0	.	0	.	.	.	-	0	+
7.3	Provide additional hiking trails	-	.	0	0	-	-	.	0	.	0	+	.	.	-	+	+
7.4	Natural areas acquisition	.	.	.	+	+	+	+	+	+	+	+	+	.	+	.	+
7.5	Massachusetts Scenic Recreation Rivers Act	+	+	+	+	.	+	+	+	+	.	.	+	.	+	+	+
7.6	Establish greenbelts	+	.	.	+	.	+	+	.	+	+	.	+	.	0	+	+

1/ (+) Maintains or improves present situation. (-) Adverse impact expected. (0) Could have adverse and/or favorable impact. (.) No significant impact is expected.
2/ (+) No irreversible or irretrievable commitment of resources. (-) Involves an irreversible and irretrievable commitment of resources.

CHAPTER 9

PROGRAM IMPLEMENTATION
of
ALTERNATIVES

9.1 INTRODUCTION

This chapter identifies program opportunities available for implementing the alternatives identified in Chapter 8. Existing federal, state, and local programs are outlined, which will enable the alternatives to result in action. The desired result of the Massachusetts Water Resources Study is that it be a catalyst for action designed to meet the needs of the region.

9.2 OPPORTUNITIES FOR USDA PROGRAMS

Programs of agencies which are active or may be established in the region will be discussed. Ongoing programs should receive first priority when considering implementation of alternatives. New programs may require a number of years to be implemented. Table 9.1 summarizes programs and agencies applicable to the various alternatives. Programs are listed under the principal agency responsible for their administration.

9.2A Soil Conservation Service Programs

Conservation Operations Program -- This is the ongoing program of the Soil Conservation Service. Technical assistance is available through the county conservation districts for the planning and installation of measures to develop and conserve natural resources. Field offices located in Acton and Holden provide this technical assistance in the Central Region.

Assistance is available to local communities in the development of Erosion and Sediment Control Ordinances (Alternative 3-1). Sample bylaws have been developed by the National Association of Conservation Districts and governmental research agencies. Communities can also

utilize the ordinances of nearby communities for guidance. Personnel from the Soil Conservation Service can assist towns in recognizing the special erosion and resource management needs of their particular community. This service is also available to individuals and groups within communities.

Technical assistance is available to the conservation districts in preparing the Inventory of Cropland with Serious Erosion Problems (Alternative 3-3). Technical assistance is also available to landowners desiring to reduce erosion losses through the utilization of conservation practices.

Soil Survey Program -- Soil Surveys conducted by the Soil Conservation Service include the mapping, classification, correlation, and interpretation of soils according to national standards. Soil mapping has been completed for much of the Central Region (See Figure 5-17). Communities may accelerate the completion of mapping by sharing the cost of soil surveys within the town boundaries. The soil survey program of the Soil Conservation Service can be used to implement Alternatives 1-2, 5-1, and 6-1.

Soil surveys are an essential element of basic data for the identification of prime agricultural land, and are a first step in any program to protect prime agricultural land from urban development. Alternative 1-2, Preserve Agricultural Land, will rely on accurate soil survey data being available.

Public Law 83-566 -- The Small Watershed Protection and Flood Prevention Act provides technical and financial assistance to solve land and water problems. Flood prevention must be a major concern in each watershed. This Act can be used to implement Alternatives 2-2, 2-4, and 5-1, and assist with Alternatives 7-1, 7-2, and 7-3.

Federal cost sharing is available to provide 100 percent of the cost of structural measures to provide flood protection, and 50 percent of the cost of multi-purpose reservoir storage allocated to recreation or fish and wildlife developments. Non-PL-566 cost sharing must be provided by local sponsors who must also provide all necessary land rights needed for project installation.

At the present time, federal cost sharing for nonstructural or flood-proofing methods of reducing flood damage is not available under PL-566 or other federal flood protection programs. PL-566 can, however, assist local communities to develop plans for nonstructural flood protection, if this is the most feasible and acceptable alternative. All installation costs must be borne by non-PL-566 funds.

The structural measures studied for each watershed with significant damage predominantly include the use of floodwalls or earthen dikes to provide flood protection to an industry or business that sustains major damage. In many cases, residential damage remains, since there is no feasible system of protecting this property in most of the watersheds. Reservoir sites have been encroached upon or have been completely developed with buildings. In other cases, the flat topography limits the number of potential flood prevention sites. In the areas with a large percentage of upstream wetlands, peak flood flows are often below the minimum release rates required for design of a floodwater retarding structure.

Water development projects or local flood control measures should not be carried out under Public Law 83-566 when federal assistance can be provided under more appropriate authorities. This is the case for many of the strictly structural alternatives which protect the major damage area, usually an industry located along the banks of the river. PL-566 can, however, be utilized to plan and implement projects and local protection measures combined with other water resource development, where other authorities are less appropriate.

Massachusetts Natural Resources Planning Program (MNRPP) -- This local initiative program enables communities to inventory their natural resources, to rate those resources against standards, and to determine the consequences of proposed actions on the natural resource base. A Regional Technical Team is available to assist the townspeople to assess their resources and problems. Graduate student interns work with local residents to collect and analyze data.

The Massachusetts Natural Resources Planning Program is a useful tool in assessing the magnitude of resource problems and in developing courses of action to solve the problems. Preservation of Agricultural Land (Alternative 1-2), Critical Area Inventories (Alternative 3-3), Wetlands Acquisition (Alternative 4-1), Conservancy Zoning (Alternative 4-2) and Wetlands Restriction (Alternative 4-3) should all be more easily implementable in a town participating in the Massachusetts Natural Resources Planning Program. Basic inventories needed for the program, and the increased public awareness of the natural resource base will be useful in laying the foundations for implementation of alternatives.

Resource Conservation and Development Program (RC&D) -- Within Massachusetts, two RC&D areas have been established. These are The Pilgrim RC&D Area, which includes Bristol, Plymouth, Dukes, Barnstable, and Nantucket Counties, and the Berkshire-Franklin RC&D Area, which includes Berkshire and Franklin Counties. Both of these RC&D areas are entirely outside of the Central Region.

A RC&D area if established in the region, could serve as a vehicle for implementing many alternatives, such as Structural Flood Protection and other measures where social or economic benefits to the area will result. Up to 100 percent federal cost sharing for technical assistance and structural measures for flood control is available. Local sponsors must provide all necessary land rights.

A RC&D area could also assist in implementing Alternative 1-5, Establish a Program to develop diversified markets for forest products, and other forestry alternatives.

9.2B Forest Service Programs

Renewable Resources Program -- This is an "umbrella" program which combines many of the Forest Service authorities into a unified group of systems for recreation, wildlife, timber, land and water conservation, and human and community development. The Forest Service cooperates with the Massachusetts Department of Environmental Management, Division of Forests and Parks, to conduct forestry programs on state and privately owned forest land.

The Renewable Resources Program can provide assistance to forest landowners to Increase Management of Public and Private Forest Land (Alternative 1-3), assist in establishing a Program to Develop Diversified Markets for Forest Products (Alternative 1-5), and to assist in the establishment of an Information and Education Program to Inform Landowners About Benefits of Forest Management (Alternative 1-6).

9.2C Farmers Home Administration Loans and Grants

The FmHA has a number of loan and grant programs designed to encourage the economic development of rural areas. These programs can be used by the region's rural communities to help implement alternatives.

Loans are available to assist sponsoring public agencies in Resource Conservation and Development Areas. Soil and water loans are designed to aid farm landowners to make better use of their farmland. Watershed Protection and Flood Prevention loans help PL-566 sponsors to provide the local cost of structural measures. In addition, loans and grants are available to improve rural water systems.

Farmers Home Administration loans and grants could assist in implementing Alternatives 1-2, 2-2, 2-4, 3-3, and 5-2.

9.2D Agricultural Stabilization and Conservation Service (ASCS)

Agricultural Conservation Program (ACP) -- This program places increased emphasis on rural pollution abatement, as well as: (1) providing incentives for landowners to carry out soil and water conservation

practices where benefits in relation to costs are long deferred or that provide significant offsite benefits; (2) encouraging farmers and ranchers to carry out whole-farm long-term conservation plans that emphasize conservation benefits of national concern and aid in preventing pollution of air, soil and water. ACP will provide both technical and financial assistance to farmers whose land is a source of agricultural pollution or affected by wind or water erosion. Cost sharing generally ranges from 50 to 75 percent but can range up to 90 percent on critical problem areas where priorities have been developed by local committees. This program can aid in implementation of Alternatives 3-2 and 3-3 to reducing erosion and sediment.

Forestry Incentives Program (FIP) -- This is a production oriented program which provides federal cost sharing on tree planting and timber stand improvement to private landowners. Emphasis is placed upon:

1. increasing the future supply of softwood sawtimber;

2. continued sustained yield, multi-purpose management of private nonindustrial forest land;

3. cost-effectiveness of forest improvement practices as measured by a continuing evaluation.

Cost sharing ranges from 50 to 75 percent. This program can aid in implementation of Alternatives 1-2, 1-3, and 1-4 to preserve and improve forest land.

9.3 OPPORTUNITIES FOR OTHER PROGRAMS

Information on other federal assistance programs exists in the current "Catalog of Federal Domestic Assistance," Executive Office of the President, Office of Management and Budget, Washington, D.C.

Some of the federal programs applicable and pertinent to this study are discussed below:

9.3A Federal Programs

National Flood Insurance Program -- The Department of Housing and Urban Development, through the Federal Insurance Administration, provides communities with the opportunity to participate in the National Flood Insurance Program. Flood insurance is available through local agents for residents of towns which qualify for the program. In return for federally subsidized insurance rates, the community must agree to consider flood hazards before approving development and to severely limit development of flood prone areas. All except three of the Central Region communities are enrolled in the flood insurance program which implements Alternative 2-1, Flood Insurance.

Land and Water Conservation Fund -- The Land and Water Conservation Fund administered by the U.S. Department of the Interior, Heritage Conservation and Recreation Service, provides cost sharing assistance to finance recreation and open space programs. The Fund could assist in implementing Alternatives 4-1, 7-1, 7-2, 7-3, and 7-4.

9.3B State Programs

Forestry Programs -- The Department of Environmental Management, Division of Forests and Parks, cooperates with the U.S. Forest Service to assist forest landowners to make the best use of the forest resource. This program can aid in the implementation of Alternative 1-3, Increased Management of Forest Land, and Alternative 1-6, Information and Education to Inform Forest Landowners of Benefits of Management.

The Forest Land Assessment Act, General Laws, Chapter 61, can be used to maintain forest land in the face of rising real estate taxes, thus, helping to implement Alternative 1-4, Increase Incentives to Manage Forest Land.

Wetlands Programs -- The Wetlands Restriction Section of the Department of Environmental Management administers the Wetlands Restriction Act. Increased staff or greater use of outside consultants will be necessary if Alternative 4-3, Accelerate Wetlands Restrictions, is to be accomplished.

The Massachusetts "Wetlands for Wildlife" program of the Division of Fisheries and Wildlife has purchased wetland areas in the region for their wildlife habitat value. This program can be utilized to implement Alternative 4-1, Wetlands Acquisition. The Division of Conservation Services could assist municipalities to acquire wetland areas through the Massachusetts Self-Help program.

Recreational Programs -- The Department of Environmental Management is the agency which would be responsible for implementing the Massachusetts Scenic and Recreational Rivers Act (Alternative 7-5). The department has established a pilot program for the North River on the South Shore to gain experience in administering the act.

Massachusetts General Laws, Chapter 32A, Section 11, as amended, makes funds available to communities for acquiring recreational conservation lands.

Alternative 7-3, Establishment of Canoe Trails, could also be administered under ongoing programs of the Department of Environmental Management.

Reservoir Programs -- The Division of Water Resources of the Department of Environmental Management under Massachusetts General Laws, Chapter 767 of the Acts of 1970 has funds available from a bond issue to acquire and protect potential reservoir sites. Funds may be available from this source to investigate and protect potential surface water reservoir sites (Alternatives 5-1 and 5-2).

9.3C Regional Programs

Regional planning agencies are the logical group to assist communities to establish erosion and sediment control ordinances (Alternative 3-1). Technical assistance and guidance is available from the Soil Conservation Service through the local Conservation District. A number of "model" ordinances are available which can be adapted to fit local conditions.

Land Use Programs -- Recently enacted Agricultural Preservation and Restoration Act under Chapter 780 of the Acts of 1977, Massachusetts General Laws, will be administered by the Division of Conservation Services working in cooperation with local Conservation Commissions. Starting with a pilot program, the Act will seek to halt the development of critical farmland through the purchase of development rights (Alternative 1-2).

The Horticultural Land Assessment Act under Chapter 61A of the General Laws can also be used in a multi-faceted approach to encourage the preservation of agricultural land use.

TABLE 9.1

IMPLEMENTATION OF ALTERNATIVES BY PROGRAM AND AGENCY
(Indicated by x)

ALTERNATIVES	Resource Cons. & Development (RC&D) Soil Cons. Service	Cons. Operations Soil Cons. Service	Soil Survey Soil Cons. Service	Small Watershed Program (PL-566) Soil Cons. Service	Natural Resources Planning Program Soil Cons. Service	Renewable Resources Program Forest Service	Agri. Cons. Program (ACP) Agri. Stabilization & Cons. Serv.	Forestry Incentives Program (FIP) Agri. Stabilization & Cons. Serv.	Loans & Grants Farmers Home Administration	National Flood Insurance Dept. of Housing & Urban Development	Land & Water Cons. Fund Heritage Cons. & Rec. Service, USDI	Potential Reservoir Funds (DWR) Dept. of Environmental Management	Forestry Programs Dept. of Environmental Management	Wetlands Restriction Program Dept. of Environmental Management	Recreation Programs Dept. of Environmental Management	Wetlands for Wildlife Dept. of Fish & Wildlife & Rec. Veh.	Self-Help Program Div. of Cons. Services	Regional Planning Agencies	Horticultural Land Assessment Act Cities & Towns	Agri. Land Acquisition & Preservation Mass. Dept. of Agriculture
1.1 Ignore loss of agricultural land	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1.2 Preserve agricultural land	.	.	x	.	x	.	x	.	x	.	.	.	.	.	.	.	.	.	x	x
1.3 Increase forest management	x	x	.	.	.	x	x	x	.	.	.	.	x	.	.	.	.	.	.	.
1.4 Increase forest utilization & mgt. incentives	.	x	.	.	.	x	x	x	.	.	.	.	x	.	.	.	.	.	.	.
1.5 Develop markets for forest products	x	.	.	.	.	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.
1.6 Estab. forestry info & education program	x	.	.	.	.	x	.	x	.	.	.	.	x	.	.	x	.	.	.	.
2.1 Participation in Flood Insurance Program	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.
2.2 Structural flood protection	x	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.
2.3 Floodproofing and nonstructural	x	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.
2.4 Structural and floodproofing	x	.	.	x	.	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.
3.1 Erosion & sediment control ordinances	.	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.
3.2 Cropland erosion program	.	x	x	.	.	.	x	.	x	.	.	.	.	.	.	.	.	.	.	.
3.3 Stream buffer zone	.	x	.	.	x	.	.	.	.	.	x	.	.	.	.	.	x	x	.	.
4.1 Wetlands acquisition	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	x	x	.	.	.
4.2 Expand wetland zoning	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.
4.3 Accelerate Inland Wetland Restriction Program	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	.	.	.	.	.
5.1 Investigate potential water supplies	.	.	.	.	x	.	.	.	.	.	.	x	.	.	.	.	.	.	.	.
5.2 Acquire or protect water supply sites	.	.	.	.	.	.	.	.	x	.	.	x	.	.	.	.	.	.	.	.
6.1 Complete soil surveys	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7.1 Provide additional campsites	.	.	.	.	.	.	.	.	.	x	.	.	.	x	.	.	.	.	.	.
7.2 Provide additional picnic tables	x	.	.	.	.	.	.	.	.	.	x	.	.	.	x	.	.	.	.	.
7.3 Provide additional hiking trails	x	.	.	.	.	.	.	.	.	.	x	.	.	.	x	.	x	.	.	.
7.4 Natural areas acquisition	x	.	.	.	.	.	.	.	.	.	x	.	.	.	x	.	x	.	.	.
7.5 Massachusetts Scenic Recreation Rivers Act	x	.	.	.	.	.	.	.	.	.	.	.	.	.	x	.	x	.	.	.
7.6 Establish greenbelts	x	.	.	.	x	.	.	.	.	.	x	.	.	.	.	x	x	.	.	.

CENTRAL REGION

APPENDIX A

Prime Potential Reservoir Sites

1. Summary

The potential reservoir sites which are presented in this appendix represent the prime possibilities for permanent water storage sites in the Coastal Region which are not already under active consideration for development. Topography, geology, and affected man-made facilities appear to be favorable. More detailed geologic and engineering investigations need to be made before sites are acquired. If future needs for a reservoir site in a particular area can be identified, steps should be taken to acquire the site at an early date so that development in the area does not make reservoir costs excessive. Early acquisition or protection of these potential reservoir sites is essential to conserve these important natural resources for future use.

2. Previous Studies

The Soil Conservation Service has completed and published inventories of potential reservoir sites in the Central Region. Reservoir locations were selected on the basis of suitable topography, relatively undeveloped pool areas, and certain drainage area, pool area, and storage characteristics. Inventory data which was prepared included a surficial geologic investigation, list of man-made facilities which would be inundated and preliminary designs and cost estimates for various levels of development.

The inventories provide a valuable source of basic information about more than 395 potential reservoir sites in the region. No attempt was made in the inventories to evaluate the potential of the sites for specific purposes such as water supply, recreation, etc. Unfortunately, many of the sites which first appear promising fail to meet the more stringent criteria required for a good water supply or low-flow augmentation reservoir. Among the more common problems are poor geologic conditions, recent development of the pool area, and extremely high cost.

3. Site Evaluation

The purpose of this appendix is the presentation of the most promising potential reservoir sites in the Central Region. Inventories of potential sites for the Merrimack, Assabet, Concord, Sudbury, Nashua, Blackstone, and Thames Study Areas were used as the source of basic data. Many sites were quickly eliminated from further consideration because of obvious problems

connected with geologic conditions and extensive effects on man-made facilities. The relatively flat topography in the region also eliminated many sites; large shallow areas tend to produce poorer quality water supply than deep sites. Likewise, low-flow augmentation and recreation uses tend to favor the deeper pools.

The remaining sites were individually evaluated for potential uses. Table A-1 summarizes information for the sites which appear to have potential for permanent storage of water. More detailed information concerning the individual sites is available in the Inventory of Potential and Existing Reservoir Sites for the particular area.

4. Protection of Sites

These potential reservoir sites are an important natural resource. They are examples of unique situations combining suitable topography to provide efficient storage, good geologic conditions which limit excessive seepage losses, and relatively undeveloped, lower cost, reservoir areas. Many of the potential reservoir sites in Massachusetts have been lost for future utilization through poor or uninformed land use decisions. Residential and commercial development in the state has encroached on the potential reservoir area of a number of otherwise suitable sites. In many instances, wetland protection measures have been effective in preserving the stream and the adjoining wetlands. However, the higher nonwetland areas which would be needed to provide deep water storage potential have been subject to development with little restriction. As a result, a potential deep water storage site with good geology may be economically infeasible because of the high cost involved in removing encroaching development.

State and local governments must begin to recognize the importance of protecting this dwindling natural resource--the natural potential reservoir site--from loss through default. The result of inaction in this area will not be catastrophic. Loss of a potential reservoir site is a more subtle loss which may not become apparent for several years until needs for water supply or water-based recreation cannot be easily or economically met. Then it will become apparent that preservation of these sites would have been in the public interest. The purchasing of houses in a potential water supply reservoir is socially disruptive to a community as well as being highly expensive. Development in a potential recreation or fishing pool area usually represents the loss of the site as costs per surface acre become prohibitive. It would appear to be more prudent to establish a program of early acquisition of potential reservoir sites in order to safeguard the areas from development pressures.

A note of caution is necessary at this point. All of the data which has been prepared for the potential site inventories is based on preliminary data which should be substantiated and reinforced before site acquisition is undertaken. Among the most important items which need to be developed

before acquisition is a detailed subsurface geologic investigation to ascertain the materials which are present. Analyses needs to be made of the potential for seepage into the ground water. Current appraisals of land costs by competent professionals are also needed.

If a future need for the site can be identified; and if the detailed studies show the site to offer practical potential, steps should be undertaken to limit unwise development of the area. Purchase of the site is one possibility. Acquisition of development rights is another. A third possibility might be donation of the land for conservation purposes by public-spirited citizens. Even if acquisition of a potential reservoir area does not appear feasible, governments can take steps to make development compatible with future use of the area. Highway locations can be realigned to skirt reservoir sites. Developers can be encouraged to keep potential pool areas as undeveloped green space to complement the developed areas. Town boards can avoid locating schools, sanitary landfills, and other municipal improvements on potential reservoir areas.

If steps are not taken to protect these potential reservoir sites from unwise or uninformed development, they will likely be too costly to acquire in the future. They will be lost for future reservoir use unless timely action is undertaken to protect and preserve them to meet anticipated needs.

CENTRAL REGION

TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION	
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Eleva- tion - Mean Sea Level (feet)	Volume (acre- feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Eleva- tion - Mean Sea Level (feet)	Area (acres)
ME-1203	Dunstable	2.0	186	180	0.3	186	540	2.2	186	130
ME-1309	Tyngsborough	1.4	154	350	0.8	148	600	2.5	154	90
ME-1503	Dracut	4.2	108	980	2.5	102	1800	7.5	109	270
ME-1505	Dracut	1.4	125	270	0.7	122	580	2.4	125	90
ME-1508	Dracut	1.3	135	160	0.3	135	480	2.0	135	90
ME-1513	Andover	5.8	112	1570	3.9	103	2450	10.3	112	380
ME-1804	Carlisle	5.9	188	510	1.1	188	1570	6.6	188	380
ME-2006	Boxford	1.1	94	120	0.2	94	380	1.6	94	70
ME-2009	Methuen	1.2	156	170	0.4	156	530	2.2	156	80
ME-2026	Haverhill	1.3	154	190	0.4	154	590	2.5	154	50
ME-2130	West Newbury	1.4	50	140	0.3	50	440	1.9	50	90
AS-1712	Northborough	1.4	365	320	0.9	358	640	2.7	365	60
SU-1706	Hopkinton	4.8	273	890	2.8	270	2070	8.7	273	330
NA-0101	Ashby	4.7	1093	310	1.6	1093	940	3.9	1093	120
NA-0102	Ashby	8.7	1033	1690	5.2	1024	3520	14.8	1033	240
NA-0203	Ashburnham	4.7	953	230	1.3	953	700	2.9	953	60
NA-0204	Ashburnham	1.3	1068	300	0.8	1062	590	2.5	1068	70
NA-0205	Ashburnham/ Westminster	1.0	979	230	0.7	972	460	1.9	979	40
NA-0210	Westminster	1.0	1031	230	0.7	1027	430	1.8	1031	70
NA-0222	Westminster	1.4	964	320	0.9	954	630	2.6	964	40
NA-0313	Leominster	1.8	764	410	1.2	758	750	3.2	764	90
NA-0318	Fitchburg	1.2	945	330	0.8	930	530	2.2	945	40
NA-0703	Harvard	1.0	383	220	0.6	380	400	1.7	379	70
NA-0709	Harvard	7.5	282	1640	4.7	274	3190	13.4	282	270
NA-0803	Lunenburg	2.5	365	550	1.6	358	1060	4.5	365	100
NA-0807	Lunenburg	2.8	361	580	1.7	358	1120	4.7	357	190
NA-0822	Lunenburg	1.0	485	240	0.7	480	450	1.9	485	60
NA-0901	Lunenburg	10.1	363	760	3.6	363	2320	9.8	363	390
NA-0904	Shirley	1.0	321	150	0.5	321	470	2.0	321	50
NA-0907	Lunenburg	5.2	428	760	2.7	428	2350	9.9	428	190
NA-1001	Ashby	1.7	865	390	1.1	859	720	3.0	865	90
NA-1005	Ashby	3.8	757	550	2.0	757	1680	7.0	757	120
NA-1020	Ashby	2.9	683	560	1.7	678	1260	5.3	683	110
NA-1104	Pepperell	1.9	308	490	1.3	301	790	3.3	308	120

CENTRAL REGION
TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION	
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Eleva- tion - Mean Sea Level (feet)	Volume (acre- feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Eleva- tion - Mean Sea Level (feet)	Area (acres)
BL-6106	Millbury	4.7	563	1010	2.9	556	1990	8.4	563	200
BL-6206	Grafton	1.3	374	300	0.8	369	580	2.4	374	80
BL-6212	Sutton	2.0	550	450	1.3	543	850	3.6	550	90
BL-6401	Douglas	1.0	653	230	0.6	646	450	1.9	653	50
BL-6404	Douglas	1.4	551	320	0.9	544	620	2.6	551	60
BL-6405	Douglas	2.1	517	450	1.3	512	850	3.6	517	130
BL-6416	Uxbridge	1.3	433	130	0.6	433	410	1.7	433	60
BL-6502	Northbridge	4.7	390	1040	3.0	385	2160	9.1	390	210
BL-6503	Sutton	1.2	542	280	0.8	532	520	2.2	542	40
BL-6508	Sutton	2.6	519	580	1.6	511	1130	4.7	519	90
BL-6514	Douglas	2.7	683	600	1.7	674	1180	5.0	683	90
BL-6516	Uxbridge	2.4	332	540	1.5	326	980	4.1	332	130
BL-6603	Grafton	1.0	411	190	0.6	409	400	1.7	407	70
BL-6613	Upton	1.4	357	240	0.8	354	580	2.4	357	70
BL-6622	Uxbridge	3.1	271	500	1.7	270	1440	6.0	271	90
BL-6624	Uxbridge	1.2	273	50	0.3	273	150	0.6	273	20
BL-6625	Uxbridge	1.0	353	70	0.4	353	220	0.9	353	60
BL-6626	Mendon	2.5	334	390	1.4	332	1050	4.4	334	80
BL-6701	Mendon	1.8	336	410	1.2	331	780	3.3	336	110
BL-6702	Mendon	1.1	243	220	0.7	238	480	2.0	243	60
BL-6703	Blackstone	1.9	273	320	1.1	270	800	3.4	273	80
BL-6704	Mendon	3.6	246	660	2.1	242	1470	6.2	246	170
BL-6705	Milford	4.9	343	570	2.2	343	1760	7.4	343	210
BL-6804	Wrenham	4.6	250	900	2.7	248	1870	7.9	246	290
TH-0101	Monson	1.4	746	220	0.8				746	50
TH-0103	Wales	1.0	890	230	0.7	882	410	1.7	890	50
TH-1A01	Brimfield	1.2	700	190	0.7	700	590	2.5	700	50
TH-1A03	Brimfield	1.3	737	210	0.7	737	660	2.8	737	40
TH-1A04	Warren	1.1	819	190	0.6	816	500	2.1	819	30

CENTRAL REGION

TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION	
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Elevation - Mean Sea Level (feet)	Volume (acre-feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Elevation - Mean Sea Level (feet)	Area (acres)
TH-1A12	Charlton	2.3	717	220	1.0	717	670	2.8	717	155
TH-1A14	Charlton	1.0	782	110	0.5	782	350	1.5	782	70
TH-1A17	Charlton	1.3	648	240	0.8	644	490	2.1	652	80
TH-1A21	Charlton/ Sturbridge	6.5	634	1390	4.4	626	2810	11.8	634	190
TH-1A22	Charlton	5.8	604	610	2.8	604	1880	7.9	604	140
TH-1A25	Dudley	1.4	519	260	0.9	516	670	2.8	527	50
TH-1A28	Southbridge	9.4	535	790	4.2	535	2430	10.2	535	120
TH-1A33	Holland	1.7	692	270	1.0	690	720	3.0	702	80
TH-1A34	Holland	1.8	777	360	1.2	773	810	3.4	777	90
TH-1A37	Holland	2.5	918	440	1.5	917	1180	5.0	918	140
TH-1A38	Brimfield	1.7	725	90	0.5	725	280	1.2	725	110
TH-0206	Oxford	1.7	644	150	0.7	644	470	2.0	644	110
TH-0209	Charlton	2.5	665	390	1.4	665	1180	5.0	665	90
TH-0211	Charlton	3.9	655	760	2.5	652	1590	6.7	655	250
TH-0216	Charlton	1.1	798	230	0.7	798	710	3.0	798	70
TH-0219	Spencer	1.8	879	70	0.4	879	200	0.8	879	120
TH-0226	Leicester	2.0	946	310	1.1	946	950	4.0	946	60
TH-0227	Webster	1.8	468	240	0.9	468	730	3.1	468	120
TH-0236	Leicester	1.3	975	300	0.9	970	600	2.5	975	70
TH-0255	Douglas	1.0	649	180	0.6	646	430	1.8	654	50

Levels of development presented in this table were selected to illustrate the maximum potential for each use.

Water supply is based on a safe yield of 0.6 million gallons per day per square mile of drainage area or the maximum safe yield of the site; whichever is less.

Low flow augmentation is based on 8 inches of runoff volume from the drainage area, or the maximum storage available at the site; whichever is less.

Recreation is based on the lesser of: the maximum surface area available at the site, or the surface area which is one-tenth of the drainage area size.

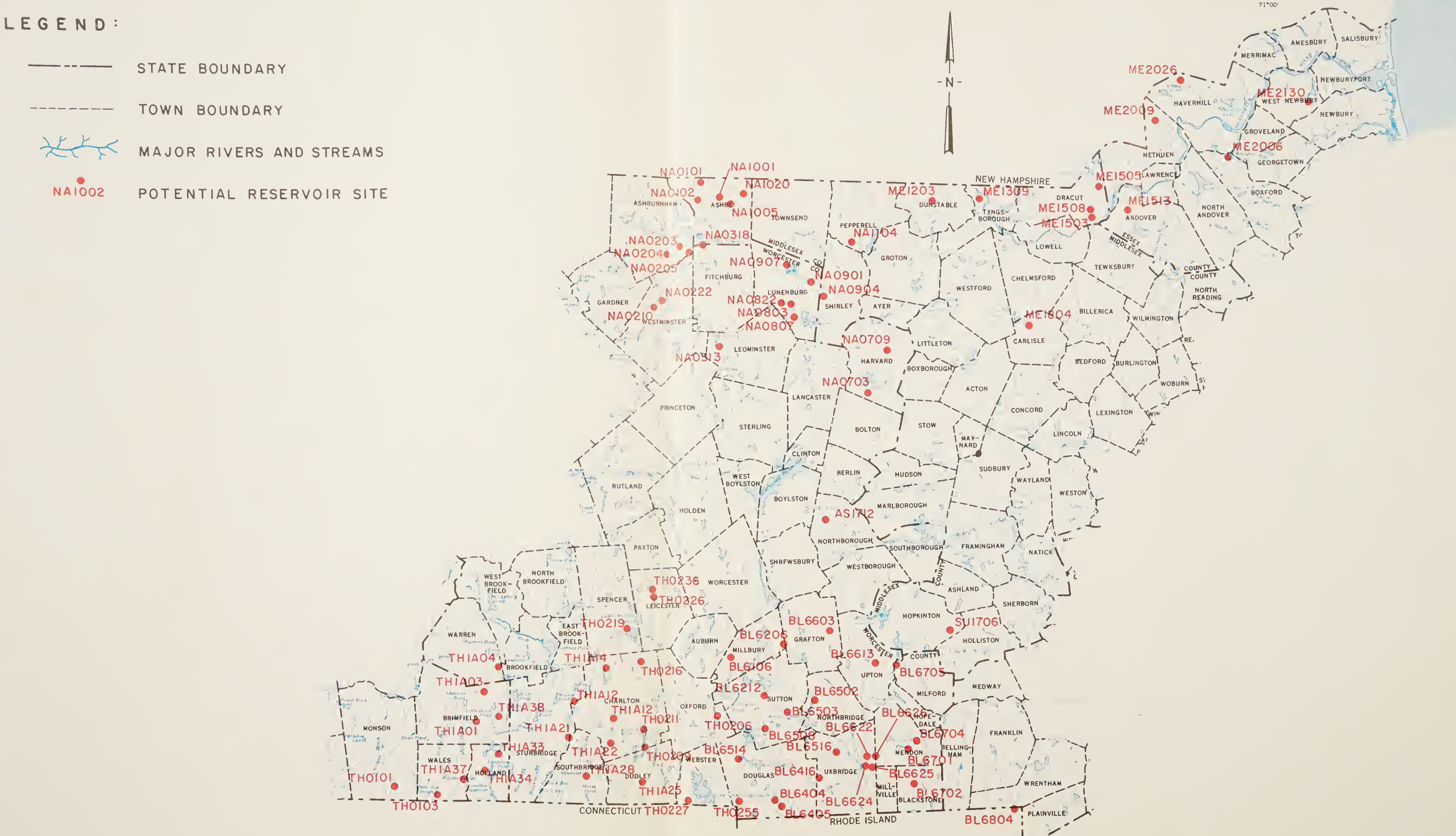

FIGURE A1

POTENTIAL RESERVOIR SITES

CENTRAL REGION

MASSACHUSETTS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

APPENDIX B

Wetland Evaluation Criteria

This section contains the criteria used to evaluate major wetlands in the Central Region. Each of the 79 wetlands evaluated was subjected to map study and a field examination. Ratings were assigned based on point values obtained for various attributes. Rationale for each evaluation item is also contained in this appendix to explain the background concerning development of the criteria.

The wetland evaluation criteria were developed by an interdisciplinary team of USDA specialists. Draft criteria were circulated among federal, state and regional agencies for comments and suggestions.

The criteria, with modifications, may be helpful in assessing the smaller wetlands of a community. Development of the evaluation procedure was based upon a regional approach and certain criteria, such as size, may need to be altered to fit local situations. The numerical rating values might also need to be modified to account for factors which might be important from a local basis but insignificant on a regional scale.

WETLAND EVALUATION

Wetland Name ______________________ No. ____ Date ______

Wetland Location (City or Town) ______________________

Investigator ______________________

Ownership (Public - give name; or Private) ______________________

Size (acres) ________ Drainage System ______________________

Type Classification (acres per type) ______________________

____

Surrounding Topography ______________________

Flora ______________________

____

Fauna ______________________

____

Current Use ______________________

Adjacent Land Use ______________________

Nearness to Houses, etc. ______________________

Potential Pollution Problem ______________________

Accessibility ______________________

Potential Storage Depth at Outlet ________ft. (vertical distance from normal water level to top of control structure)

Size of outlet structure if any ______________________

Rating Summary

Forest Management ______________ Recreation ______________

Flood Control ______________ Uniqueness ______________

Fish Habitat ______________ Visual Quality ______________

Wetland Wildlife Habitat ______________

Comments

____

____

____

____

WETLAND EVALUATION

Wetland Name ______________________ No. ______

FORTEST MANAGEMENT[1/]

CRITERION	RANGE	Circle Correct RATING
1. Public ownership of forested wetland	>30%	3
	15-30%	2
	<15%	1
2. Stand size class distribution[2/] (sawtimber, poletimber, seedling-sapling)	<80% in any 2 classes	3
	>80% in any 2 classes	2
	>80% in any 1 class	1
3. Portion of forest land with 81-100% crown closure	>80%	6
	30-80%	4
	<30%	2
4. Portion of wetland forested	>60%	3
	30-60%	2
	<30%	1
5. Predominant forest cover type	Cedar, red maple, larch/tamarack or green ash	9
	Hemlock, black ash or black spruce	3
6. Shape of forested wetland	Block	3
	Long narrow strip	1
7. Type of soil	Mineral	6
	Peat	2
8. Accessibility	Roads in wetland	6
	Roads leading to but not in wetland	4
	No roads leading to wetland	2
	Total circled items: ________	

RATING: Greater than 28 = High
24 to 28 = Moderate
Less than 24 = Low

Rating is: ______________

1/Wetlands containing less than 5 acres of forest should not be rated. Insert NR in rating blank.

2/ If wooded areas are inaccessible for inspection MacConnell's height classes may be used:

Classes 1 & 2 Seedling-Sapling
Classes 3 & 4 Poletimber
Class 5 Sawtimber
Class 6 - rates high (3)

WETLAND EVALUATION

Wetland Name ______________________________ No. ______

FLOOD CONTROL

CRITERION	RANGE		Circle Correct RATING
1. Effective storage of wetland on total watershed above.	<1" runoff 1"-3" runoff >3" runoff		0 6 9
2. Effective storage of upstream reservoirs and wetlands on total watershed.	<1" runoff 1"-3" runoff >3" runoff		3 2 1
3. Effective storage on main stem between wetland and Potential Damage Area or major confluence.	<1" runoff 1"-3" runoff >3" runoff		8 4 0
4. Distance downstream to Potential Damage Area	<1 mile 1-5 miles over 5 miles		3 1 0
5. Severity of Potential Flood Damage (downstream)	<3 miles	Low Moderate High	2 4 8
	or 3-5 miles or below major confluence	Low Moderate High	1 2 4

Total circled items: ______

RATING: Total is: Less than 15 = Low
15 to 23 = Moderate
24 or greater = High RATING is: ____________

WETLAND EVALUATION

Flood Control

Instructions for Each Item on the Evaluation Sheet

1. The effective storage can be estimated by expected increase in wetland water elevation (a) during a large (approx. 100 year) flood times (x) the wetland area times (x) 12 divided by the drainage acres.

$$\text{Effective Storage (in inches runoff)} = \frac{\text{Change in elevation} \times \text{wetland area} \times 12}{\text{drainage acres}}$$

 (a) Where there is a control at outlet of wetland, change in elevation will be estimated by field observation. Where there is no control, use attached curves.

2. Effective storage of upstream reservoirs and wetlands is estimated as under Item 1 and includes all storage in the drainage area above the wetland being evaluated, but not the wetland storage.

3. Effective storage on the main stem below the wetland being evaluated and the major part of the damage area. This is the storage of the downstream channel or wetland (inches) divided by the total drainage above the damage area (acres).

4. This is a visual estimate using aerial photos, quad sheets, personal knowledge or observation.

5. This is to be a comparison rating based on aerial photos, quads, personal knowledge and observation. Damage which might occur to that which replaces and surrounds the wetland should also be considered.

 Potential Damage: Low - agriculture, scattered residences, secondary roads
 Moderate - >low but <high
 High - concentrated residences, commercial, industrial, primary roads.

Limitation of Wetland Rating

The following system of evaluating wetlands as to their effectiveness in controlling floodwaters categorizes the wetland as: low, medium or high. No attempt should be made to compare wetlands within a category on the sole basis of the numerical rating.

Procedure for Wetland Evaluations

1. Use one sheet for each wetland.
2. Begin at upper end of drainage and work downstream.
3. The downstream wetland of two wetlands in series should be partially completed before rating the upper wetland.

WETLANO EVALUATION

Wetland Name ______________________________ No. ______

FISH HABITAT 2/

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	5	4 (with some type 5 present)	Other
2. Size (acres of Type 5) 1/	50+	>25 but <50	<25
3. Location of wetland	Immediately adjacent to a lake which supports warm water fish.	Immediately adjacent to a perennial stream that supports warm water fish.	Adjacent to intermittent stream or cut off from streams.
Presence of fish cover	Abundant	Limited	Scarce
Presence of game fish (number of species present)	2 or more	1	None

Total number of items circled in (a) ______ (b) ______

Calculation:
No. circled in column (a) x 2 + no. circled in column (b) x 1 = ______

RATING: Total is: 8 to 10 = High
5 to 7 = Moderate
0 to 4 = Low

RATING IS: ______

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, O.C., 1971.

2/ There must be some type 5 present to evaluate the wetland for this use. If not rated insert NR in rating blank.

This table is to be completed on drainages with more than one wetland.
Wetland areas should be listed working downstream.

Wetland or Other Control	Drainage (ac.)	Storage (ac./ft.)	Storage (in.)	Upstream Storage (ac./ft.)	Upstream Storage (in.)	Downstream Storage (ac./ft.)	Downstream Storage (in.)

WETLAND EVALUATION

Wetland Name ______________________ No. ____

WETLAND WILDLIFE HABITAT

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	3 or 4	5, 6 or 7	1, 2 or 8
2. Number of wetland types 1/	3 or more	2	1
3. Diversity of adjacent land use (other than urban types) 2/	3 or more	2	1
4. Percent of perimeter with 300'+ wide buffer strip 3/	80%+	60%+ but <80%	<60%
5. Size (acres)	200 or more	100+ but <200	<100
6. Islands	Yes	---	No

Total number of items circled in: (a) ____ (b) ____

Calculation:
No. circled in column (a) x 2 + no. circled in column (b) x 1 = ________

RATING: Total is: 9 to 12 = High
5 to 8 = Moderate
0 to 4 = Low

RATING IS: ________

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, United States Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

2/ The following types will qualify for the diversity determination:
1 type - forestland (any or all type(s) present will collectively constitute the equivalent of one diversity type)
1 type - unused tillable (TU), pasture (T), orchard (O)
1 type - abandoned field (AF), abandoned orchard (AO)
1 type - sand or gravel removal (SG) (inactive)
1 type - recreation land--any one or more of the following types:
RG - golf course, RD - golf driving range, RSK - ski area,
RFG - fairground, RP - urban park

3/ Buffer strip = area adjacent to wetland perimeter without occupied buildings or other urban uses.

WETLAND EVALUATION

Wetland Name ______________________ No. ____

RECREATION

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
BOATING: (Pleasure and Fishing - canoe and flat bottom)			
1. Principal Wetland Type used for boating (4 or 5)	5	4	All others
2. Acres available (per continuous wetland 4 & 5)	100+	>50 but <100	<50
3. Physical Access (No. of Access Points)	2+	1	0
4. Boatable Stream Present	(enters and leaves wetland)	(enters or leaves wetland)	none present
FISHING: (shoreline)			
5. Principal Wetland Type used for fishing (4 or 5)	5	4 (with some type 5 present)	other
6. Wetland Size (acres)	50+	>25 but <50	<25
7. Physical Access--shore Percent of shoreline from which fishing is available	20%+	5%+ but <20%	<5%
NATURE STUDY:			
8. Diversity of plants and animals (number of types)	3 or more	2	1
9. Percent of urban development within 300 feet of wetland perimeter.	<5%	5% to <25%	25%+
HUNTING:			
10. Waterfowl hunting - amount of Type 3, 4 and 5	100 acres+	25+ but <100	<25 acres
11. Access for hunting	Unlimited	Permission of landowner required	None available

Total number of items circled in (a) ____ (b) ____

Calculation:
No. circled in column (a) x 2 + no. circled in column (b) x 1 = ________

RATING: Total is: 16 to 22 = High
9 to 15 = Moderate
0 to 8 = Low

RATING IS: ________

WETLAND EVALUATION

Wetland Name ______________________ No. _____

UNIQUENESS

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Location - wetland surrounded by:	Intensely urban	Suburban	Rural
2. Wetland supports a threatened, endangered, or uncommon species of plant or animal	A threatened or endangered species	An uncommon species	None
3. Wetland contains a regionally rare plant community 1/	Yes	--	No
4. Wetland attracts a regionally significant number of migrating birds	Yes	--	No
5. Wetland is archaeologically, geologically or historically significant	Yes	--	No
6. Size: (acres)*	500 acres and more	200 acres or more but <than 500 acres	<200 acres

Total number of items circled in: (a) ______ (b) ______

Calculation:
No. circled in column (a) x 2 + no. circled in column (b) x 1 = ____________

RATING: a. Any item 2-6 rating high = High
b. Total is: 3 to 6 = Moderate
0 to 3 = Low

RATING IS: ____________

1/ Occurs less than 5% of the time in inventoried wetlands.

* Uniqueness due to size may need evaluation by region in Massachusetts. The north and southeastern sections of the state have wetland areas qualifying (under for the above categorization; Western and Central Massachusetts should be re-evaluated in terms of overall wetland size.

WETLAND EVALUATION

Wetland Name ______________________ No. ________

VISUAL QUALITY

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. One or more public roads enables travelers to overlook the wetland at	3+ different locations or 1 mile or more	2 different locations or 1/4 mile+ but <1 mile	1 location or <1/4 mile
2. Overlooks accessible by-path or trail	2 or more overlooks accessible	1 overlook accessible	No overlooks accessible
3. Wetland contains some type 7 wetland consisting of deciduous woodland	75+ acres of red maple	40+ but <75 of red maple	<40 acres
4. Surrounding topography provides potential for developing overlooks	Potential for 2 or more different overlooks	Potential for 1 overlook	No potential for an overlook
5. Wetland contains an island	Yes	---	No
6. Appearance and condition	Undisturbed an natural	Somewhat disturbed and littered	Messy, littered filling, junky
7. Wetland types	Wetland contains some visible Type 4 or 5	Wetland contains some Type 2 or 3	Wetland contains no visible Types 2, 3, 4 or 5

Total number of items circled in (a) ______ (b) ______

Calculation:
No. circled in column (a) x 2 + no. circled in column (b) x 1 = ____________

RATING: Total is: 10 to 14 = High
5 to 9 = Moderate
0 to 4 = Low

RATING IS: ____________

Rationale - Forest Management

CRITERION 1 - PUBLIC OWNERSHIP

Publicly owned forestland is more prone to multiple use management which includes wood fiber production as one of the uses.

CRITERION 2 - STAND SIZE CLASS DISTRIBUTION

The optimum size class distribution is 50 percent sawtimber, 25 percent poletimber and 35 percent seedling-sapling. Sawtimber trees are live trees of commercial species that have the following minimum diameters at breast height--softwoods 9.0 inches and hardwoods 11.0 inches. Poletimber trees are live trees of commercial species at least 5.0 inches in diameter at breast height but smaller than sawtimber size. Seedling-sapling trees are live trees of commercial species with diameters at breast height of less than 5.0 inches.

CRITERION 3 - STAND DENSITY

Optimum wood fiber production is achieved when the stand is fully stocked. One measure of stocking is the amount of crown closure. The greater portion of the forest that is at or near full stocking, the higher the potential for wood fiber production.

CRITERION 4 - PORTION OF WETLAND FORESTED

The greater the amount of the wetland forested, the greater the potential for wood fiber production, and the greater the incentive for the landowner to manage the land for forest products.

CRITERION 5 - FOREST COVER TYPE

The forest cover type of any area is determined by the principal species present. Cedar, red maple, larch/tamarack or green ash are the cover types that have the highest value for wood fiber production. Management of these types would be the most profitable.

CRITERION 6 - SHAPE OF FORESTED WETLAND

A block of forestland of some regular shape is more conducive to management than a long narrow strip of forestland, as might be found along a waterway.

CRITERION 7 - TYPE OF SOIL

The volume of wood that can be grown on a site is directly related to the soil. Peat soils generally produce wood fiber at a much slower rate and poorer quality than mineral soils.

CRITERION 8 - ACCESSIBILITY

Forestland that has roads to and through it is more conducive to management because road construction is one of the major expenses of forest management.

Rationale - Flood Control

To evaluate wetlands for their value in flood control three basic factors are considered, these are: (1) the actual storage, (2) the effectiveness of that storage, (3) the existing need for control downstream (damage potential).

1. The effective storage of a wetland in relation to its drainage area is the single most important factor in flood control. As the inches of runoff storage increases, the more significantly are flows extended over a longer period of time, thus reducing the peak flows from any given storm.
2. Effective upstream storage by reservoirs and other wetlands may already be controlling the flows to the extent that the storage in question may have little effect, even though it has a very effective storage volume.
3. Main stem storage upstream of a potential damage area can have the same effect on peak flows as another wetland. Also, small streams entering a large stream generally have a significantly reduced effect on flows below that point.
4. The effect of a wetland decreases as you move downstream from it. This is because of two things, first, the routing effect of the stream channel and flood plain itself and secondly, as you move downstream the drainage area becomes progressively larger and the considered wetland has less effect.
5. The value or importance of a wetland for flood control is reduced if there is little or no potential for damage downstream regardless of how effective it may be.

Rationale - Fish Habitat

Principal Wetland Type - Type 5 is the only freshwater wetland type that can support fish in all seasons. Type 4 is suitable in spring and fall, but some Type 5 must be present to maintain fish during summer and winter.

Size - The larger the wetland the more fish it will physically support. One hundred acres was considered necessary to rate high in a regionwide inventory.

Location of Wetland - Wetlands are often used for spawning habitat by warm water species of fish. Some species of fish (e.g., golden shiner, chain pickerel) require aquatic vegetation for spawning sites. Warm water lake fishery is dependent on wetland acreage for spawning sites, nutrient inflow, and as young fish rearing areas. Perennial streams supporting warm-water fish benefit from wetlands, but generally less so than lakes. Intermittent streams do not support substantial fishery.

Presence of Fish Cover - Warm-water fish require logs, stumps, pond lilies, watershield, etc. for protective cover. If the wetland surface is covered with 35 percent or more with stumps, lilies and other plants, it will have a rating of abundant; 10 percent or more, but less than 35 percent will rate as moderate; less than 10 percent as scarce.

Presence of Game Fish - If the wetland is included in "An Inventory of the Ponds, Lakes and Reservoirs of Massachusetts" by James A. McCann (published by Water Resources Research Center, University of Massachusetts) and has a specified productivity of 60 or more pounds of fish per acre, the rating will be high. If listed productivity is 40 or more, but less than 60, the rating will be moderate. If listed productivity is less than 40 pounds per acre, the rating will be low.

If the wetland is not included in "An Inventory of the Ponds, Lakes, and Reservoirs of Massachusetts," then the rating will be based on the following:

High rating - 2 or more species of game fish are present
Moderate rating - 1 species of game fish is present
Low rating - no species of game fish is present.

Game fish shall be limited to brook trout, brown trout, largemouth bass, chain pickerel, and northern pike.

Rationale - Wetland Wildlife Habitat

These criteria were developed to rate wetlands for wetland wildlife habitat. Species in this category include shorebirds, waterfowl, herons, bittern, beaver, muskrat, otter, and associated songbirds (e.g., yellow warbler, tree swallow, red-winged blackbird, marsh wren, kingfisher, etc.).

Principal Wetland Type - For wetland wildlife Types 3 and 4 1/ were considered the most valuable. In the northeast 3/4 or more of the Type 3 and 4 wetlands are classified of prime importance to waterfowl. These types are also of high value to the other forms of wetland wildlife itemized above. Types 5, 6 and 7, although not providing as great a diversity of plant life, are of moderate value to wetland wildlife.

Types 1, 2 and 8 are either only infrequently wet or support a very limited diversity of plants (bogs).

Although all wetland types provide habitat for certain species of wildlife, the criteria emphasizes those types with permanent water for the wetland wildlife rating.

1/ Wetlands of the United States, Circular 39, U.S. Department of the Interior, 1971.

Number of Wetland Types - The greater the number of types in a single wetland the greater will be the diversity of flora and fauna in that wetland. Diversity is a common parameter for measuring quality.

Diversity of Adjacent Land Use - Adjacent land uses provide additional feeding or nesting sites for many of the wetland wildlife species.

Buffer Strip - A 300 foot wide or greater buffer strip without occupied buildings or other intensive uses will serve to protect the amenities of the wetland. Buffer strips provide nesting habitat for many species of wetland wildlife. Seventy-five percent of all duck nests are found within 300 feet of water. Nests are seldom found closer than 100 feet of buildings.

Size - A minimum wetland size was necessary to prevent excessive expenditures of time on the wetland inventory portion of the river basin studies. The minimum size varies in different regions of the state depending upon the number and size of wetlands present. It is the intent of the inventory to include only the more significant wetlands in each region, however, smaller wetlands of regional significance may be included.

Islands - Islands provide a preferred nesting site of the mallard, teal and black duck. Islands offer natural protection from predators reluctant to travel over water to reach the island.

Islands also usually provide a diverse vegetative condition especially when the island elevation exceeds 3 feet above the normal water elevation of the wetland.

Rationale - Recreation

These criteria were developed to rate the value of a wetland for canoe or flat bottom boating, fishing, nature study and hunting. These were considered to be the primary recreation activities conducted on wetlands.

Boating

Principal Wetland Type - Type 5 (inland open Freshwater) consists of open water up to 10 feet deep and because it is deep was rated the best suited for boating use.

Type 4 was rated as moderate value for boating because its depth ranges from only 6 inches to 3 feet and it supports a substantial amount of emergent and floating aquatic plant growth.

All other wetland types were considered unsuitable for boating because of: lack of standing water or dense vegetation.

Acres Available - The more boatable water available, the more desirable the boating activity. Continuous wetland means that the wetland inventoried is either one single wetland or is two or more boatable wetlands linked by a boatable stream.

Physical Access - Physical access means that it is convenient to launch a canoe or flat bottom boat without excessive carrying distances or without having to push the craft out through dense woody vegetation to reach open water.

Boatable Stream Present - Access is facilitated and it is more desirable if a boatable stream enters, crosses and leaves a wetland area.

Fishing

Principal Wetland Type - Type 5 is the only wetland type of sufficient depth to support fish during all seasons. Type 4 will support fish in spring and fall but there is likely to be oxygen deficiencies in summer and winter, therefore, the presence of some Type 5 is essential.

Size - The larger the wetland the more attractive it is for fishing and the more fish will be supported. One hundred acres or more in size was considered necessary to rate high in a regionwide inventory.

Physical Access - Shore - Many persons, particularly children desiring to fish do not have boat equipment and their fishing is limited to the shoreline. Some open shoreline free of woody plants and dense herbaceous plants is necessary for casting.

Nature Study

Diversity of Plants and Animals - Each wetland type supports a variety of wetland flora and fauna. The greater the number of wetland types present in the wetland the greater will be the diversity of flora and fauna. The more diversity present the better will be the nature study opportunities.

Wetland Perimeter - Urban development in the 300 foot wide strip would detract from the nature study values of a wetland (noise, pollutants, litter, domestic animals, trail bikes, etc.).

Hunting

Waterfowl Hunting - Types 3, 4 and 5 are the most attractive wetlands for waterfowl and consequently for waterfowl hunting. Although any size wetlands of these types will attract waterfowl, a 100 acre plus wetland was considered to be significant on a regionwide basis.

Access for Hunting - Hunting is only possible where permitted by the landowner or governing agent.

Rationale - Uniqueness

Location of Wetland - There are few situations where wetlands are located in intensely urbanized areas. Where this is the case, the wetland provides many people with the opportunity to observe or study the diverse flora and fauna within the wetland. Close proximimity to schools offers the potential for formal study by school biology and earth science classes.

Threatened, Endangered or Uncommon Species - Science is as yet ignorant of the net results of a species being exterminated and until mankind becomes this sophisticated in his knowledge of the natural environment we had best tread lightly. The diversity of species is an indicator of environmental quality and when the diversity is reduced the environmental quality is likewise reduced. Man is a part of the natural environment and must co-exist with other species in this natural environment.

Migrating Birds - Offers the public an opportunity to see unusual wildlife concentrations.

Archaeologic, Geologic or Historic Significance - This determination will be sought from local, regional and state authorities (e.g. State Historical Society, Regional Planning Authority).

Size - Any wetland greater than 200 acres in size is uncommon in the Commonwealth of Massachusetts.

Rationale - Visual Quality

The visual quality of a wetland is largely dependent upon the wetland's openness and available access from which people can view it. Wetland Types 1/ 2, 3, 4, and 5 are the more open types which people can look at.

Roads around or through a wetland enable people to look out over the wetland even though they don't care to walk into its interior. For those persons wanting to see a wetland, paths or trails facilitate access.

Islands add to the diversity of flora within a wetland and, therefore, contribute to the wetland's visual quality.

Litter detracts from a wetland's appearance and, therefore, absence of litter is a positive factor.

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

APPENDIX C

<u>Public Lakes, Ponds and Reservoirs</u>

Prepared by the Massachusetts Division of Water Resources

The objective of this phase of the study is to compile a comprehensive listing of public ponds, lakes and reservoirs relative to size, access, flowage rights and ownership, as well as water. The Massachusetts Water Resources Study principals have come to realize that the ownership of our water resources is a question of paramount importance to the public.

Current information on water body status as a public or private resource is often incomplete, inaccurate or out-of-date. Within the framework of this study, the Massachusetts Division of Water Resources found the appropriate opportunity to gather some new information. It is planned that this survey will be continued eventually to cover the entire state and made part of a permanent record system.

At the study's outset, available existing information was used heavily to produce a rough, preliminary working list. Sources used included Department of Public Works (DPW) and Department of Environmental Quality Engineering (DEQE) records, the University of Massachusetts County Lakes, Ponds and Reservoirs Inventories by McCann, et al., in addition to earlier studies conducted by the Division of Fisheries and Wildlife. These sources produced an extensive working list refined according to certain criteria to establish eligibility for the final listings.

A primary purpose of this survey is to identify water bodies which should be available for public use. It was found that certain waters could be eliminated quickly. Except for municipally-owned reservoirs over 20 acres, and water bodies within state or federally owned land, natural ponds under 10 acres and wholly man-made private reservoirs were excluded. As a result of applying these criteria, only ponds, lakes and reservoirs of apparent public status and significance remain on this final listing for the Central Region.

It should be noted that the designation of "apparent public or great pond status" does not preclude the occurrence of private ownership of some of the water bodies so labeled. However, this classification should signal the need for a full survey pursuant to Chapter 91 or 131 of the General Laws to clear up any remaining question of status on water bodies within this category. When a pond's public status has been ascertained, access can be provided by the Massachusetts Public Access Board acting pursuant to the authority contained in Section 17 of Chapter 21 of the Massachusetts General Laws.

Basic Facts Regarding Great Ponds as Provided by the Colony Ordinance of 1641-7 and Its Interpretations

Size
Great Ponds are those over 10 acres, except regarding fishing where rights exist in ponds over 20 acres.

Ownership
Pond bottom is owned by the state below the ordinary low water mark.

Rights
Use by the public, so long as one does not trespass on a man's "corn or meadow." A right also exists to seek the provision of a public access to avoid such trespass.

Uses
Fishing, fowling, boating, bathing, skating or riding upon the ice, taking of water for domestic or agricultural purposes, or for use in the arts and the cutting and taking of ice.

Enlarged Great Ponds
Public rights exist in the entire waters of an enlarged natural great pond. In discussing this, Massachusetts Water Laws (1970) states:

> "A reflection upon all of the cases which have been reviewed seems to establish conclusively that all public rights in natural great ponds...can be lawfully exercised in any part of the waters which are impounded by dams erected at the outlet of great ponds containing more than 10 acres, except the public right of fishing, which right will be restricted to natural great ponds exceeding 20 acres in size."

By checking records of the county engineer and by comparing the heights of dams with depth data, many enlarged great ponds can be identified. Even with such research and onsite inspections, some water bodies could not definitely be assumed to be great ponds. Formal surveys by the Waterways Division could ascertain their status.

It should be noted that this list is not, therefore, official. It represents our best judgment, bearing in mind that exact measurements are required in borderline cases. The problem of great pond identification is most difficult where an original natural pond has been enlarged by the construction of a dam at its outlet.

The significance of the study is manyfold. It indicates those ponds where the right of public access exists and can be developed under existing law.[1/]

1/ Caveat--No right exists to walk along privately-owned shorelines once access is obtained. Public access rights may also be denied by the local water authority where a pond is withdrawn for water supply. Uses may be regulated by towns and state agencies, as authorized by statute.

It also suggests that other lakes not listed are currently private. Where important private water bodies exist, public funds might be expended to obtain usage rights where appropriate.

CENTRAL REGION
Massachusetts Water Resources Study
Index of Towns Selected to Represent Each Study Area

MERRIMACK STUDY AREA

Amesbury	Lawrence
Andover	Merrimac
Burlington	Methuen
Chelmsford	Salisbury
Dracut	Tewksbury
Dunstable	Tyngsborough
Haverhill	Westford
Littleton	West Newbury
Lowell	

BLACKSTONE STUDY AREA

Auburn	Millville
Blackstone	Northbridge
Douglas	Sutton
Grafton	Upton
Hopedale	Uxbridge
Mendon	Worcester
Millbury	

THAMES STUDY AREA

Brimfield	Oxford
Charlton	Southbridge
Dudley	Sturbridge
Holland	Wales
Leicester	Webster

NASHUA STUDY AREA

Ashby	Leominster
Ayer	Lunenburg
Boylston	Pepperell
Clinton	Princeton
Fitchburg	Shirley
Groton	Sterling
Harvard	Townsend
Holden	West Boylston
Lancaster	Westminster

SUASCO STUDY AREA

Sudbury River

Ashland	Sudbury
Framingham	Southborough
Hopkinton	Wayland
Marlborough	

Assabet River

Acton	Maynard
Berlin	Northborough
Bolton	Boxborough
Carlisle	Shrewsbury
Concord	Stow
Hudson	Westborough

Concord River

Bedford	Billerica

NASHUA STUDY AREA COMMUNITIES

1. Ashby

Ashby Reservoir #4-9-12-1* (NA-10)+ — 42 Acres

This is an artificial, municipal water supply reservoir. Flowage rights are with the city of Fitchburg, and the reservoir is currently closed to public use.

Damon Pond (NA-10) — 1.5 Acres

This is a small artificial pond located within the Willard Brook State Forest under the jurisdiction of DEM's Division of Forests and Parks. Informal public access is available across this state land for swimming and shore fishing.

Fitchburg Reservoir #4-9-12-2 to 4 (NA-10) — 147 Acres

This is another artificial, municipal water supply reservoir with the dam and flowage rights controlled by the city of Fitchburg. No public access is permitted at present.

Watatic Pond (NA-1) — 21 Acres

This is an apparent natural great pond with no formal public access.

Wright Pond (Upper Wright Pond) (NA-10) — 15 Acres

This apparent natural great pond has no formal public access. Presently it is stocked by the Division of Fisheries and Wildlife (DFW&RV).

Wright Pond West (Lower Wright Pond) (NA-10) — 21 Acres

This is an apparent natural great pond with no formal public access. The Division of Fisheries and Wildlife (DFW&RV) stocks the pond, at present.

2. Ayer

Long Pond #4-9-19-2 (NA-7) — 60 Acres

This is an enlarged great pond surveyed by the Division of Waterways (DEQE) which has no formal public access. The Ayer Conservation Commission controls the dam and flowage rights.

2. Ayer (continued)

Sandy - Flanagan - Balch Pond #4-9-19-4 (NA-7) — 155 Acres

This enlarged great pond surveyed by Division of Waterways (DEQE) contains the waters of these adjoining ponds controlled by the same dam, which is owned by the town of Ayer. The Division of Fisheries and Wildlife currently stocks the pond. At present, there is no formal public access.

Spectacle Pond (ME-14) — 79 Acres

(See Littleton)

3. Boylston

Newton Pond #3-14-271-7.1 (BL-63) — 50 Acres

(See Shrewsbury)

Pout Pond (BL-63) — 14 Acres

This is an apparent natural great pond with no formal public access.

Rocky Pond #3-14-39-2 (AS-17) — 65 Acres

This is an apparent enlarged great pond with no formal public access. The dam and flowage rights are controlled by Clayton Jenks.

Sewall Pond (BL-63) — 11 Acres

This is an apparent natural great pond for which there is no formal public access.

Wachusett Reservoir #3-14-64-2 (NA-6) — 4135 Acres

This apparent enlarged great pond serves as part of the water supply for the Boston Metropolitan area. The MDC owns the dam and flowage rights. At present, shore fishing is allowed in certain areas; informal access is available to the public over this Wachusett Reservoir Reservation. A fishing permit must be obtained annually from the MDC at 20 Somerset Street, Boston ($1.00 fee).

4. Clinton

Clamshell Pond (AS-17) — 24 Acres

This is a natural great pond surveyed by the Division of Waterways (DEQE) with no formal public access provided.

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* DEQE, Division of Waterways, Dam Inspection File Identification Number.
\+ Soil Conservation Service Subwatershed Designation.
(NA) Nashua Drainage (TH) Thames Drainage (ME) Merrimac Drainage
(BL) Blackstone Drainage (CO) Concord Drainage

C-4

4. Clinton (continued)

Coachlace (Mossy)(South Meadow Pond) #3-14-64-3, 3A (NA-6) 119 Acres

This is an apparent enlarged great pond with no formal public access. The Massachusetts Division of Fisheries and Wildlife presently stocks the pond. The dam and flowage rights are with the Lancaster Engineering Co.

Wachusett Reservoir #3-14-64-2 (NA-6) 4135 Acres

(See Boylston)

5. Fitchburg

Lovell Reservoir #3-14-97-34 (NA-3) 34 Acres

This is an artificial, municipal water supply reservoir. The city of Fitchburg controls the dam and flowage rights. At present, the area is closed to public recreational use.

Scott Reservoir #3-14-97-37 (NA-3) 31 Acres

This is another artificial, municipal water supply reservoir for which there is no public access. The dam and flowage rights are controlled by the city of Fitchburg.

6. Groton

Baddacook Pond (ME-12) 76 Acres

This natural great pond has been identified by the Massachusetts Division of Waterways (DEQE). Public access has been obtained by the Massachusetts Division of Fisheries and Wildlife (DFW&RV). This agency presently stocks the pond with fish. Public access for boating has been developed by the Massachusetts Public Access Board.

Cow Pond (ME-12) 38 Acres

This apparent natural great pond has no formal public access.

Duck Pond (ME-12) 19 Acres

This is a natural great pond surveyed by the Division of Waterways (DEQE). No public access has been established.

Knops Pond #4-9-115-4 (ME-12) 204 Acres

This is an apparent enlarged great pond with public access obtained and developed by the Massachusetts Division of Fisheries and Wildlife. The dam and flowage rights are controlled by the American Baptists Convention. It is stocked currently by Division of Fisheries and Wildlife.

6. Groton (continued)

Martins Pond (ME-12) 20 Acres

This is an apparent natural great pond for which there is no public access.

Wattles Pond (NA-11) 10 Acres

This is an apparent natural great pond with no public access.

7. Harvard

Bare Hill Pond #3-14-125-1 (NA-7) 316 Acres

This is an enlarged great pond surveyed by the Division of Waterways (DEQE). The town of Harvard controls the dam and flowage rights. Formal public access has been obtained by the Massachusetts Public Access Board but it has not been developed. A town beach has been developed for town residents.

Little Hell Pond (NA-7) 8 Acres

This small natural public pond is located within the U.S. Army's Fort Devens Reservation. Fishing by permit is allowed at present.

Mirror Lake (NA-7) 31 Acres

This is an apparent natural great pond located within the Fort Devens Military Reservation. Public fishing is presently allowed by permit only.

Robbins Pond (NA-7) 15 Acres

Here is an apparent natural great pond under the jurisdiction of the U.S. Army within the Fort Devens Reservation. Fishing is allowed with a military permit.

8. Holden

Holden Reservoir #1 (Upper Holden Reservoir)
#3-14-134-3 (BL-61) 125 Acres

This is an artificial, municipal water supply reservoir. The city of Worcester controls the dam and flowage rights. At present, the reservoir is closed to the public.

Holden Reservoir #2 (Lower Holden Reservoir)
#3-14-134-2 (BL-61) 55 Acres

An artificial, municipal water supply reservoir which has been closed to public access. The dam and flowage rights are owned by the city of Worcester.

8. Holden (continued)

Kendall Reservoir #3-14-134-4, 4A, 4.1 (NA-5) 166 Acres

This is an artificial, municipal water supply reservoir for which public access is prohibited. The city of Worcester controls the dam and flowage rights.

Maple Spring Pond (Peter Carr's Pond) #3-14-134-11 (NA-5) 41 Acres

This is an artificial, municipal water supply reservoir with no formal public access. The city of Worcester controls the dam and flowage rights.

Pine Hill Reservoir (NA-5) 331 Acres

(See Paxton)

Quinapoxet Reservoir #3-14-134-10 (NA-5) 256 Acres

This is an enlarged great pond surveyed by the Division of Waterways (DEQE) and used for water supply by the city of Worcester. The dam and flowage rights are controlled by the city. One or more licenses to withdraw water exist on the reservoir. It is presently closed to public use.

Unionville Pond #3-14-134-13 (NA-5) 22 Acres

This is an artificial pond which has no formal public access. The dam and flowage rights are controlled by the MDC. Fishing is permitted.

9. Lancaster

Cranberry Pond (NA-7) 10 Acres

This is an artificial pond under the jurisdiction of the U.S. Army within the Fort Devens Reservation. Fishing is allowed by a military permit.

Fort Pond (NA-8) 74 Acres

Public access for boating has been developed by the Massachusetts Public Access Board to the public waters of this enlarged natural great pond surveyed by the Division of Waterways (DEQE). The pond is presently stocked for fishing by the Massachusetts Division of Fisheries and Wildlife.

Little Spectacle Pond (NA-4) 11 Acres

This is an apparent natural great pond with no formal public access.

9. Lancaster (continued)

Spectacle Pond (Big Spectacle Pond) (NA-8) 58 Acres

Informal public access to the public waters of this natural great pond, identified by the Massachusetts Division of Waterways (DEQE), is across federal land in the Fort Devens Military Reservation. A boat ramp has been developed, and the pond is stocked by the Massachusetts Division of Fisheries and Wildlife (DFW&RV). Fishing is by military permit.

White Pond #3-14-143-15 (NA-4) 48 Acres

Here is an enlarged great pond surveyed by the Division of Waterways (DEQE) with no formal public access. The dam is controlled by L. & B. Fluet.

10. Leominster

Fall Brook Reservoir #3-14-153-27 (NA-4) 76 Acres

This is an artificial, municipal water supply reservoir. The city of Leominster controls the dam and flowage rights. At present the reservoir is closed to the public.

Haynes Reservoir #3-14-153-24 (NA-3) 55 Acres

This is an artificial, municipal water supply reservoir for which access is prohibited. The dam and flowage rights are owned by the city of Leominster.

Notown Reservoir (Leominster Reservoir) #3-14-153-12 (NA-3) 233 Acres

Here is an artificial, municipal water supply reservoir. Flowage rights are with the city of Leominster, and the reservoir is closed to the public.

Rocky Pond (NA-3) 18 Acres

This apparent natural great pond is located in Leominster State Forest, administered by the Department of Environmental Management, Division of Forests and Parks. Informal access for recreation is available to this pond across the state land.

Whalom Pond (NA-8) 94 Acres

(See Lunenburg)

11. Lunenburg

Massapoag Pond (NA-8) 55 Acres

This is an apparent natural great pond with no formal public access. The dam has been breached.

C-6

11. Lunenburg (continued)

Shirley Reservoir (Shirley Pond) #3-14-162-11 (NA-8) 354 Acres

This is an apparent enlarged great pond with no formal public access. The Lake Shirley Improvement Corporation controls the dam and flowage rights.

Whalom Pond (NA-8) 94 Acres

This enlarged great pond has been surveyed by the Massachusetts Division of Waterways (DEQE). Formal public access for boating has been developed by the Massachusetts Public Access Board. The dam and flowage rights are controlled by the Commonwealth of Massachusetts. It is presently stocked by the Division of Fisheries and Wildlife (MDFW&RV).

12. Pepperell

Heald Pond (NA-11) 22 Acres

This is an apparent enlarged great pond with no formal public access. The dam and flowage rights are controlled by the town of Pepperell. The Conservation Commission owns the surrounding land for protection of the town wells.

13. Princeton

Crow Hill Pond #3-14-332-27 (NA-2) 11 Acres

This artificial pond is located within Leominster State Forest under the jurisdiction of Massachusetts Division of Forests and Parks (DEM). This agency also controls the dam and flowage rights. Access for fishing and swimming is available and the pond is stocked by Massachusetts Division of Fisheries and Wildlife.

Paradise Pond (NA-6) 61 Acres

This artificial pond is adjacent to the Leominster State Forest administered by the Massachusetts Division of Forests and Parks (DEM). This agency also controls the dam and flowage rights. Informal access for recreation is available across this state parkland and from Route 31.

Quinapoxet Reservoir #3-14-134-10 (NA-5) 256 Acres

(See Holden)

Wachusett Lake #3-14-332-21 (NA-2) 124 Acres

(See Westminster)

14. Shirley

No lakes, ponds, or reservoirs meet criteria.

15. Sterling

Fitch Pond (Fitch Pond Reservoir) (NA-6) 12 Acres

This is an apparent natural great pond with no formal public access.

Heywood Reservoir #3-14-282-11 (NA-4) 36 Acres

This is an artificial, municipal water supply reservoir. No public access is permitted at present. The dam and flowage rights are owned by the town of Clinton.

Wachusett Reservoir #3-14-64-2 (NA-6) 4135 Acres

(See Boylston)

East Waushaccum Pond #3-14-282-12A, 12.1 (NA-6) 188 Acres

This is an apparent enlarged great pond with no formal public access. The dam and flowage rights are controlled by the MDC.

West Waushaccum Pond (Middle Waushaccum Pond)
#3-14-282-12 (NA-6) 135 Acres

This is an apparent enlarged great pond which is part of the Wachusett Reservoir Watershed. The dam and flowage rights are controlled by the MDC. The pond is stocked by the Massachusetts Division of Fisheries and Wildlife. There is no formal public access.

16. Townsend

Pearl Hill Brook Pond (NA-10) .75 Acre

This small artificial pond is located within Willard Brook State Forest under the jurisdiction of the Massachusetts Division of Forests and Parks (DEM). Informal public access is available for swimming and shore fishing across this state land.

Vinton Pond (NA-10) 17 Acres

Here is an apparent natural great pond with no formal public access.

17. West Boylston

Wachusett Reservoir #3-14-64-2 (NA-6) 4135 Acres

(See Boylston)

18. Westminster

Crocker Pond (NA-2) 10 Acres

This is an artificial pond located within the Leominster State Forest under the jurisdiction of DEM's Division of Forests and Parks. At present, passive recreation is available. Informal public access can be obtained across the state land.

Mare Meadow Reservoir #3-14-140-25 (CH-29) 270 Acres

This is an artificial, municipal water supply reservoir. The city of Fitchburg controls the dam and flowage rights. Informal access can be gained across this municipal land for shore fishing.

Meetinghouse Pond #3-14-332-19, 20 (NA-2) 158 Acres

This is an apparent enlarged great pond used for water supply by the city of Fitchburg. The city owns the dam and flowage rights. The pond is presently closed to public recreational use.

Minott Pond South #3-14-332-3.1 (MI-1) 30 Acres

This is a municipally-owned artificial pond with no public access. The town of Westminster owns the dam and flowage rights.

Muddy Pond (NA-2) 21 Acres

This is an apparent natural great pond with no formal public access.

Partridge Pond (Ellis, Smith Pond) #3-14-332-10 (NA-2) 28 Acres

This is a municipally-owned artificial pond. The dam and flowage rights are controlled by the town of Westminster. Informal public access can be gained across state land in the Westminster State Forest administered by DEM's Division of Forests and Parks.

Upper Reservoir #3-14-332-1 (MI-1) 60 Acres

This is a municipally-owned artificial pond with no public access. The town of Westminster owns the dam and flowage rights.

Wachusett Lake #3-14-332-21 (NA-2) 124 Acres

This is an apparent enlarged great pond that has been withdrawn for water supply by the city of Fitchburg. The dam and flowage rights are controlled by the city.

Wyman Pond Reservoir (Grass Pond) #3-14-332-17 (NA-2) 205 Acres

This is an artificial reservoir owned by the city of Fitchburg and used for recreation. No public access is provided. The dam and flowage rights are controlled by Fitchburg.

MERRIMAC STUDY AREA COMMUNITIES

1. Amesbury

Lake Gardner #5-5-7-4 (ME-21) 107 Acres

This is an artificial, municipally-owned lake. The water rights are owned by the town of Amesbury. There is no formal public access. A municipal beach has been developed.

Lake Attitash #5-5-7-2 (ME-21) 360 Acres

Public access for boating has been obtained by the Massachusetts Public Access Board to the waters of this enlarged natural great pond. Flowage is with the town of Amesbury Water Department. A municipal boat ramp has also been developed.

Tuxbury Pond #5-5-7-1 (ME-21) 98 Acres

There is no formal public access to the waters of this artificial, municipally-owned pond. Flowage is with the town of Amesbury.

2. Andover

Delano Pond (IP-4) 6 Acres

This artificial pond is used as a fish hatchery by the Massachusetts Division of Fisheries and Wildlife, thus fishing is NOT permitted. The pond is in the Harold Parker State Forest under the jurisdiction of the Massachusetts Division of Forests and Parks, the owner of the dam. Informal access can be gained across the state land.

Brackett Pond (IP-4) 18 Acres

Brackett Pond is in the Harold Parker State Forest under the jurisdiction of the Massachusetts Division of Forests and Parks, the owner of the dam. Informal access is available to the public across the state land. This artificial pond is used as a fish hatchery by the Massachusetts Division of Fisheries and Wildlife. Fishing is NOT permitted.

Collins Pond (IP-4) 7 Acres

The Massachusetts Division of Fisheries and Wildlife uses this small artificial pond as a fish hatchery. Fishing is NOT permitted. The pond is in the Harold Parker State Forest which is administered by the Massachusetts Division of Forests and Parks. This Division owns the dam and flowage rights. Informal access is available to the public across the state land.

2. Andover (continued)

Field Pond (IP-4) 55 Acres

This artificial pond serves as a fish hatchery for the Massachusetts Division of Fisheries and Wildlife, thus fishing is NOT permitted. The pond is in the Harold Parker State Forest administered by the Division of Forests and Parks, the owner of the dam. Informal public access to the pond is available across the state land.

Fosters Pond #5-5-9-10 (ME-19) 135 Acres

No formal public access has been obtained to the waters of this enlarged natural great pond identified by the Massachusetts Division of Waterways (DEQE). Flowage is with the Foster Pond Corporation of North Wilmington.

Haggetts Pond #5-5-9-14 (ME-15) 214 Acres

This is an apparent enlarged natural great pond that has been withdrawn for use as water supply for the town of Andover. The dam is owned by the town and the pond is currently closed to public use.

Pomps Pond (ME-19) 21 Acres

No formal public access has been obtained to the waters of this natural great pond that has been identified by the Massachusetts Division of Waterways (DEQE). A municipal beach has been developed for town residents.

3. Burlington

Mill Pond #4-9-48-1 (IP-04) 65 Acres

Public fishing is presently allowed on this recently constructed artificial water supply reservoir owned by the town of Burlington. Flowage is with the Town Water Authority.

4. Chelmsford

Hart Pond #4-9-56-2 (ME-18) 91 Acres

This is an enlarged natural great pond surveyed by the Massachusetts Division of Waterways (DEQE). The Division has issued one or more licenses to withdraw water from the pond. The dam and flowage is with the town of Chelmsford, Conservation Commission. There is no formal public access to these waters.

Newfield Pond #4-9-56-4 (ME-14) 77 Acres

There is no formal public access to the waters of this enlarged natural great pond. Flowage is with the town of Chelmsford. The pond is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

5. Dracut

Long Pond (ME-15) 163 Acres

This is a natural great pond identified by the Massachusetts Division of Waterways (DEQE) for which no public access has been provided.

Mascopic Lake (ME-13) 215 Acres

(See Mascopic Lake, Tyngsborough)

Peters Pond (ME-15) 77 Acres

No public access has been provided to the waters of this natural great pond surveyed by the Division of Waterways (DEQE).

Spruce Swamp Pond (ME-15) 1 Acre

This small natural pond is contained in the Tyngsborough State Forest. Informal access is available to the public across the state land.

6. Dunstable

Massapoag Pond (ME-12) 113 Acres

(See Massapoag Pond, Tyngsborough)

7. Haverhill

Kenozo Lake (ME-21) 245 Acres

This is an apparent natural great pond that has been withdrawn for water supply by the city of Haverhill. The pond is closed to recreation.

Chadwick Pond #5-5-128-13 (ME-20) 161 Acres

No public recreation is presently allowed on the waters of this apparent enlarged natural great pond that has been withdrawn for water supply by the city of Haverhill. Flowage is with the city of Haverhill, Water Division.

Crystal Lake #5-5-128-1 (ME-20) 161 Acres

This is an artificial municipally-owned reservoir used for water supply by the city of Haverhill. Fishing is not allowed. Flowage is with the city of Haverhill, Water Division.

Lake Pentucket (ME-20) 40 Acres

Public fishing is presently allowed in the waters of this apparent natural great pond that has been withdrawn for water supply by the city of Haverhill. The pond is presently stocked with fish by the Massachusetts Division of Fisheries and Wildlife.

7. Haverhill (continued)

Lake Saltonstall (ME-20) 45 Acres

No formal public access has been obtained to the waters of this apparent enlarged great pond. Flowage is with the city of Haverhill. A town beach and boat ramp have been developed. Recreational use is presently by permit for Massachusetts residents.

8. Littleton

Forge Pond #4-9-330-1 (ME-14) 212 Acres

(See Forge Pond, Westford)

Nagog Pond #4-9-2-5 (AS-17) 284 Acres

This apparent enlarged great pond has been withdrawn for water supply by the town of Concord, the owner of the water rights. It is presently closed to recreational use.

Fort Pond (AS-17) 100 Acres

No formal access has been obtained for the public to the waters of this natural great pond. It has been surveyed by the Massachusetts Division of Waterways (DEQE).

Long Pond (AS-17) 88 Acres

This apparent natural great pond has no formal public access. A town beach has been developed.

Mill Pond #4-9-158-1 (ME-14) 54 Acres

This may be an apparent enlarged great pond. No formal public access has been obtained. The dam is owned by the Massachusetts Department of Public Works.

Spectacle Pond (ME-14) 79 Acres

This is a natural great pond surveyed by the Massachusetts Division of Waterways for which no formal public access has been obtained.

9. Lowell

No lakes, ponds, or reservoirs that meet the study criteria.

10. Lawrence

No lakes, ponds, or reservoirs that meet the study criteria.

11. Merrimac

Lake Attitash #5-5-7-2 (ME-21) 360 Acres

(See Lake Attitash, Amesbury)

12. Methuen

Forest Lake (ME-15) 55 Acres

Public fishing is presently allowed, but no formal public access has been obtained to the waters of this natural great pond identified by the Massachusetts Division of Waterways (DEQE).

Mystic Pond (ME-15) 10 Acres

This is a natural great pond that has been identified by the Massachusetts Division of Waterways (DEQE). No formal public access has been obtained.

13. Salisbury

No lakes, ponds, or reservoirs that meet study criteria.

14. Tewksbury

Long Pond (ME-19) 39 Acres

Public access to the public waters of this natural great pond, surveyed by the Massachusetts Division of Waterways (DEQE) is available across land owned by the Massachusetts Public Access Board.

Round Pond (ME-19) 23 Acres

This natural great pond has been identified by the Massachusetts Division of Waterways (DEQE). There is no formal public access.

15. Tyngsborough

Althea Lake (ME-13) 38 Acres

This is an apparent natural great pond with its shoreline partly on state land in the Lowell-Dracut State Forest under the administration of the Massachusetts Division of Forests and Parks. Informal access is available to the public across the state land.

Flint Pond #4-9-301-5 (ME-13) 60 Acres

This is an artificial publically owned pond. Flowage is with the state, Division of Fisheries and Wildlife. Public access is available across the state land. A parking lot and boat ramp have been developed.

15. Tyngsborough (continued)

Long Pond (ME-15) 163 Acres

(See Long Pond, Dracut)

Mascopic Lake (ME-13) 215 Acres

Public access for boating has been developed by the Massachusetts Division of Fisheries and Wildlife to the waters of this natural great pond that has been surveyed by the Massachusetts Division of Waterways (DEQE).

Massapoag Pond #4-9-81-2 (ME-12) 113 Acres

Formal public access has not been obtained to the waters of this apparent enlarged natural great pond. The dam is owned by the Dunstable Rod and Gun Club. The pond is presently stocked by Massachusetts Division of Fisheries and Wildlife.

16. Westford

Burges Pond (ME-14) 22 Acres

This is an apparent natural great pond. No formal public access has been obtained.

Forge Pond #4-9-330-1 (ME-14) 212 Acres

Public access has been obtained to the waters of this apparent enlarged great pond by the Massachusetts Public Access Board. The dam is owned by Murray Printing Company of Westford.

Flushing Pond (ME-14) 16 Acres

This is an apparent natural great pond for which no formal public access has been provided.

Keys Pond (ME-14) 42 Acres

There is no formal public access to the waters of this natural great pond that has been identified by the Massachusetts Division of Waterways (DEQE).

Nabnasset Pond (ME-14) 115 Acres

This is an apparent enlarged natural great pond for which no formal public access has been provided. The dam is owned by J.A.E. Realty Trust of North Chelmsford.

16. Westford (continued)

Sought For Pond (ME-14) 105 Acres

No formal public access has been provided to the waters of this natural great pond identified by the Massachusetts Division of Waterways (DEQE). It is presently stocked with fish by the Massachusetts Division of Fisheries and Wildlife.

17. West Newbury

Little Crane Pond (PA-3) 4 Acres

This small natural pond is contained in the Massachusetts Division of Fisheries and Wildlife's Crane Pond Wildlife Management Area. Informal access to these public waters is available across this state land.

Lower Artichoke Reservoir #5-5-206-3 (ME-21) 49 Acres

This is an artificial, municipal reservoir used as water supply for Newbury and Newburyport. Flowage is with the city of Newburyport, Water Commission. It is presently closed to recreation.

Upper Artichoke Reservoir #5-5-206-4 (ME-21) 196 Acres

This reservoir is used as water supply for the town of Newbury and the city of Newburyport. The dam is owned by the city of Newburyport, Water Commission. It is closed to recreation.

SUDBURY STUDY AREA COMMUNITIES

1. Ashland

Ashland Reservoir #4-9-14-4 (SU-17) 155 Acres

This artificial reservoir is located in Ashland State Park under the administration of the Department of Environmental Management (DEM), Division of Forests and Parks. Swimming, fishing and nonpower boating are available. The dam and flowage rights are controlled by DEM.

Hopkinton Reservoir #4-9-14-2 (SU-17) 170 Acres

This artificial reservoir is located within Hopkinton State Park administered by the Division of Forests and Parks, DEM. Formal public access is available for swimming, fishing and nonpower boating. DEM controls the dam and flowage rights.

Framingham Reservoir No. 2 #4-9-100-4 (SU-17) 124 Acres

(See Framingham Reservoir No. 2, Framingham)

1. Ashland (continued)

Waushakum Pond (SU-17) — 81 Acres

(See Waushakum Pond, Framingham)

2. Framingham

Farm Pond (SU-17) — 149 Acres

This natural great pond has been designated by the Division of Waterways (DEQE). There is no formal public access.

Framingham Reservoir No. 1 #4-9-100-3 (SU-17) — 162 Acres

This is an artificial reservoir owned by the MDC and used for emergency water supply. The dam and flowage rights are controlled by the MDC. The reservoir is closed to recreational use.

Framingham Reservoir No. 2 #4-9-100-4 (SU-17) — 124 Acres

This is another artificial reservoir owned by the MDC. It is used for municipal water supply. The MDC owns the dam and flowage rights. The reservoir is closed to recreational use.

Framingham Reservoir No. 3 #4-9-100-5 (SU-17) — 237 Acres

This artificial reservoir, owned by the MDC, is used for municipal water supply. The dam and flowage rights are owned by the MDC. Shore fishing (by permit) is allowed in designated areas.

Gleason Pond (SU-17) — 12 Acres

This is an apparent natural great pond with no formal public access.

Lake Cochituate #4-9-198-2 (SU-17) — 594 Acres

(See Lake Cochituate, Natick)

Learned Pond (SU-17) — 34 Acres

Here is an apparent natural great pond with no formal public access.

Waushakum Pond (SU-17) — 81 Acres

This apparent natural great pond has no formal public access.

3. Hopkinton

Duck Pond (SU-17) — 5 Acres

This is a small artificial pond located in the Hopkinton State Park administered by DEM, Division of Forests and Parks. Informal access for recreation is available across this state parkland.

3. Hopkinton (continued)

Hopkinton Reservoir #4-9-14-2 (SU-17) — 170 Acres

(See Hopkinton Reservoir, Ashland)

North Pond (Lake Maspenock) #3-14-185-3 (BL-67) — 240 Acres

This is an enlarged great pond surveyed by the Division of Waterways (DEQE). The dam and flowage rights are controlled by the Draper Corp. There is no formal public access.

Whitehall Reservoir #4-9-139-3 (SU-17) — 601 Acres

This is an apparent enlarged great pond located in Whitehall State Park administered by DEM, Division of Forests and Parks. Informal public access for fishing and boating is available across the state parkland. A boat ramp has been developed by the Massachusetts Public Access Board.

4. Marlborough

Fort Meadow Reservoir #4-9-170-1 (AS-17) — 284 Acres

This is a municipally-owned artificial reservoir used for recreation. The city of Marlborough controls the dam and flowage rights. At present access for fishing and swimming is limited to local residents except by permit for nonresidents.

Milham Reservoir #4-9-170-4 (AS-17) — 70 Acres

A municipally-owned artificial water supply reservoir for which there is no public access. The dam and flowage rights are controlled by the city of Marlborough.

Sudbury Reservoir #4-14-277-1, 2 (SU-17) — 1292 Acres

(See Sudbury Reservoir, Southborough)

William Lake #4-9-170-6 (AS-17) — 65 Acres

This is an apparent enlarged great pond used for water supply by the city of Marlborough. There is no public access. The dam and flowage rights are controlled by Marlborough.

5. Sudbury

Puffer Pond (AS-17) — 30 Acres

(See Puffer Pond, Maynard)

5. Sudbury (continued)

Willis Pond #4-9-288-2 (SU-17) 63 Acres

This apparent enlarged great pond has no formal public access. The dam and flowage rights are controlled by Frank Cutting.

6. Southborough

Sudbury Reservoir #3-14-277-1, 2 (SU-17) 1292 Acres

This artificial water supply reservoir is owned by the MDC. Informal public access is limited to shore fishing in designated areas. The dam and flowage rights are controlled by the MDC.

7. Wayland

Dudley Pond (SU-17) 84 Acres

This is a natural great pond designated by the Division of Waterways (DEQE) with no formal public access.

Heard Pond (Heards, Pelham) (SU-17) 71 Acres

This apparent natural great pond has no formal public access.

Lake Cochituate (SU-17) 594 Acres

(See Lake Cochituate, Natick)

ASSABET STUDY AREA COMMUNITIES

1. Acton

Grassy Pond (AS-17) 17 Acres

This apparent natural great pond has no formal public access.

Nagog Pond #4-9-2-5 (AS-17) 275 Acres

This apparent enlarged great pond has been withdrawn for water supply by the town of Concord. The dam and flowage rights are controlled by Concord. The pond is presently closed to recreational use.

2. Berlin

Brewer Brook Pond #3-14-28-13 (AS-17) 5 Acres

This artificial impoundment is part of a PL 566 Small Watershed Project whose primary purpose is flood control. The dam and flowage rights are controlled by the Massachusetts Water Resources Commission. Informal access for recreation is available across Commission land.

2. Berlin (continued)

Gates Pond #3-14-28-6 (AS-17) 84 Acres

This is an apparent enlarged great pond withdrawn for water supply by the town of Hudson. The dam and flowage rights are controlled by the town. Shore fishing by permit has been afforded Hudson and Berlin residents.

Ross Pond (AS-17) 10 Acres

This artificial impoundment is part of a PL 566 Small Watershed Project with the primary purpose of flood control. Informal access for recreation is available across Water Resources Commission land. The dam and flowage rights are controlled by the Commission.

3. Bolton

Delaney - East Bolton Complex #4-9-286-2 (AS-17) 168 Acres

(See Delaney - East Bolton Complex, Stow)

Little Pond (AS-17) 16 Acres

This natural great pond surveyed by the Division of Waterways (DEQE) has no formal public access.

West Pond (AS-17) 19 Acres

No formal public access has been obtained to the public waters of this natural great pond identified by the Massachusetts Division of Waterways (DEQE).

4. Boxborough

No lakes, ponds or reservoirs meet the criteria.

5. Carlisle

No lakes, ponds or reservoirs meet the criteria.

6. Concord

Batesman Pond (AS-17) 20 Acres

This natural great pond surveyed by the Division of Waterways (DEQE) has no formal public access.

Walden Pond (SU-17) 58 Acres

This great pond surveyed by the Division of Waterways (DEQE) is located within Walden Pond State Reservation. Formal public access is available for fishing and swimming across the Reservation. A beach has been developed. Power boats may not be used on this pond.

6. Concord (continued)

Warners Pond #4-9-67-4 (AS-17) — 55 Acres

This is a municipally-owned artificial pond. There is no formal public access. Fishing and nonpower boating are available for town residents only. The town of Concord controls the dam and flowage rights.

White Pond (SU-17) — 43 Acres

This natural great pond surveyed by the Division of Waterways (DEQE) has formal public access obtained by that agency.

7. Hudson

Boons Pond (Lake Boon) #4-9-286-4 (AS-17) — 165 Acres

(See Boons Pond, Stow)

Fort Meadow Reservoir #4-9-170-1 (AS-17) — 284 Acres

(See Fort Meadow Reservoir, Marlborough)

White Pond (AS-17) — 59 Acres

This is an apparent natural great pond with no recreational use allowed. The pond has been withdrawn as water supply by the town of Maynard.

8. Maynard

Puffer Pond (AS-17) — 30 Acres

This apparent natural great pond is within the U.S. Army Natick Laboratories land. No public access is presently permitted.

9. Northborough

Bartlett Pond #3-14-215-7 (AS-17) — 45 Acres

This is a municipally-owned artificial pond with no public access, although fishing and boating are available for local residents through town parkland. The town of Northborough owns the dam and flowage rights.

Little Chauncey Pond (AS-17) — 45 Acres

This is an apparent natural great pond with informal public access available over state land in the Westborough State Hospital.

Solomon Pond (AS-17) — 22 Acres

This is an apparent natural great pond with no formal public access.

10. Shrewsbury

Jordan Pond (BL-63) — 20 Acres

Here is an apparent natural great pond with no formal public access. At present, the public can obtain informal access over land owned by the town of Shrewsbury.

Flint Pond #3-14-110-8 (BL-63) — 250 Acres

(See Flint Pond, Grafton)

Lake Quinsigamond (BL-63) — 781 Acres

(See Lake Quinsigamond, Worcester)

11. Stow

Boons Pond (Lake Boon) #4-9-286-4 (AS-17) — 165 Acres

This is an enlarged great pond with no formal public access. The town of Stow controls the dam and flowage rights.

Delaney - East Bolton Complex #4-9-286-2 (AS-17) — 168 Acres

This artificial impoundment was constructed under the Watershed Protection and Flood Prevention Act (PL 566). The project a cooperative effort of federal, state, and local interests provides flood control and fish and wildlife enhancement benefits. Flowage rights are with the Water Resources Commission, the owner of the dam and surrounding land. Formal public access has been developed by the Massachusetts Public Access Board. A boat ramp to provide access for hunting and fishing has been constructed. The fish and wildlife resources are managed by the Massachusetts Division of Fisheries and Wildlife.

White Pond (AS-17) — 59 Acres

(See White Pond, Hudson)

12. Westborough

Cedar Swamp Pond (SU-17) — 17 Acres

This is an apparent natural great pond with no formal public access. Much of the surrounding swampland is owned by the MDC.

Chauncey Lake #3-14-328-12 (AS-17) — 175 Acres

This is an apparent enlarged great pond. The dam and flowage rights are owned by the Commonwealth of Massachusetts through its location on the Westborough State Hospital grounds. Formal public access for boating has been developed by the Massachusetts Public Access Board.

Hocomonco Pond (AS-17) — 27 Acres

This apparent natural great pond has no formal public access.

11. Stow (continued)

Nichols Reservoir #3-14-328-9 (AS-17) 355 Acres

This artificial impoundment was constructed under the Watershed Protection and Flood Prevention Act (PL 566). The project, a cooperative effort of federal, state, and town interests provides flood control, fish and wildlife enhancement and flow augmentation benefits. Flowage rights are with the Water Resources Commission, the owner of the dam and surrounding land. Informal access is available to the public across this Commission land.

Westborough Reservoir (Sandra Pond) #3-14-328-3, 3A, 3.1 (SU-17) 54 Acres

This is a municipally-owned artificial water supply reservoir. The town of Westborough controls the dam and flowage rights. The reservoir is presently closed to public recreational use. Fishing is presently for town residents by permit only.

CONCORD STUDY AREA COMMUNITIES

1. Bedford

Fawn Lake (ME-19) 11 Acres

This is an apparent natural great pond with no formal public access.

2. Billerica

Nutting Lake (CO-17) 78 Acres

This is a natural great pond surveyed by the Division of Waterways (DEQE) with no formal public access.

Winning Pond (CO-17) 23 Acres

This enlarged great pond has been surveyed by the Division of Waterways (DEQE). The dam and flowage rights are controlled by Middlesex County through the Department of Corrections at Billerica. The pond is closed to public recreational use.

BLACKSTONE STUDY AREA COMMUNITIES

1. Auburn

Eddy Pond #3-14-17-5 (BL-61) 130 Acres

This may be an enlarged great pond. Although public recreational use is presently allowed by the town of Auburn, the owner of the flowage, no formal public access exists. A town owned beach has been developed on a small adjacent pond, Gleason Pond.

1. Auburn (continued)

Pondville Pond #3-14-17-4 (BL-61) 30 Acres

Fishing is permitted on this municipally-owned artificial pond. Although public recreational use is presently allowed, no formal public access has been obtained. Flowage is with the town of Auburn.

2. Blackstone

Harris Pond #3-14-32-11 (BL-67) 90 Acres

Flowage on this artificial pond is owned by the city of Woonsocket, Rhode Island. The pond serves as part of the water supply of this city. Fishing is allowed by permit from the water authority.

3. Douglas

Crystal Lake (Bad Luck Pond) #3-14-77-09 (BL-65) 94 Acres

This is an apparent enlarged great pond for which no formal public access has been provided. The dam is owned by Charles and Virginia Church of Douglas.

Jeep Trail Pond (BL-64) 2 Acres

This small natural pond is surrounded by state land in the Douglas State Forest, thus informal access is available to these waters. The pond has not been developed for recreation.

Manchaug Pond #3-14-290-4 (BL-65) 310 Acres

(See Manchaug Pond, Sutton)

Railroad Pond #3-14-79-32.1 (BL-64) 2 Acres

This artificial pond is contained in the Douglas State Forest administered by the Massachusetts Division of Forests and Parks. Informal access is available across this state land. Flowage is with the Commonwealth, Division of Forests and Parks (DEM).

Wallum Lake (BL-64) 322 Acres

This is an apparent enlarged natural great pond that is partly in Burrillville, Rhode Island. Formal public access for boating has been obtained and developed by the Massachusetts Public Access Board. Informal access for the public is available across nearby Douglas State Forest under the jurisdiction of the Massachusetts Division of Forests and Parks. A swimming beach has been developed on this state land.

4. Grafton

Flint Pond #3-14-110-8 (BL-63) — 250 Acres

Formal public access for boating has been developed by the Massachusetts Public Access Board for this enlarged natural great pond, identified by the Division of Waterways (DEQE). The Flint Pond dam is also the control structure for Lake Quinsigamond in Worcester.

Hovey Pond #3-14-110-7 (BL-63) — 20 Acres

Flowage is with the Massachusetts Division of Waterways (DEQE) on this artificial public pond. Informal public access is available across adjacent state land. The pond is presently used for recreational fishing.

Lake Ripple #3-14-110-5 (BL-63) — 70 Acres

No formal public access is available to this municipally-owned artificial pond. The dam is owned by the town of Grafton, Conservation Commission.

Silver Lake #3-14-110-12 (BL-66) — 25 Acres

This is an artificial, municipally-owned pond. Flowage is with the town of Grafton. Informal public access is available from State Highway #140. The pond is used for recreation.

5. Hopedale

No lakes, ponds or reservoirs that meet the criteria.

6. Mendon

Nipmuck Pond (BL-66) — 85 Acres

This is a natural great pond, identified by the Massachusetts Division of Waterways (DEQE), for which no public access has been obtained.

7. Millbury

Dorothy Pond #3-14-186-8 (BL-62) — 145 Acres

Flowage rights are with Buck Mill Company of Millbury on this enlarged natural great pond, identified by the Massachusetts Division of Waterways (DEQE). No formal public access has been provided.

Ramshorn Pond #3-14-186-21 (BL-61) — 130 Acres

This dam is owned by Massachusetts Electric Company of Westborough on this enlarged natural great pond. There is no public access to these public waters.

7. Millbury (continued)

Singletary Pond #3-14-186-16 (BL-62) — 330 Acres

Public access for boating has been developed by the Massachusetts Public Access Board to the public waters of this enlarged natural great pond. The dam and flowage are owned by Singletary Corporation of Millbury.

8. Millville

No lakes, ponds or reservoirs that meet the criteria.

9. Northbridge

Ellis Pond (BL-65) — 4 Acres

This small natural pond is within the Upton State Forest. Informal access to these public waters can be gained across this state land.

10. Sutton

Adams Pond #3-14-290-09.1 (BL-62) — 20 Acres

This artificial pond is owned by the Massachusetts Division of Fisheries and Wildlife. Flowage is with the Division. It is part of the Stockwell Ponds system. Informal access can be gained across the state land. Fishing is permitted.

Arnold Pond #3-14-290-09.2 (BL-62) — 15 Acres

This artificial pond is owned by the Massachusetts Division of Fisheries and Wildlife, and is part of the Stockwell Ponds system. Water rights are owned by the Division. Informal access to the waters can be gained across the state land. Fishing is permitted.

Manchaug Pond #3-14-290-4 (BL-65) — 310 Acres

Formal public access to the waters of this enlarged natural great pond has been obtained by the Massachusetts Public Access Board. A boat ramp has been developed. Flowage rights are with the Manchaug Reservoir Corporation. The pond has been surveyed by the Massachusetts Division of Waterways (DEQE).

Putnam Pond #3-14-290-8 (BL-62) — 30 Acres

A part of the Stockwell Ponds system, this artificial pond is owned by the Massachusetts Division of Fisheries and Wildlife. This Division also owns the water rights. Informal public access can be gained to the pond across the state land. Fishing is permitted.

10. Sutton (continued)

School House Pond #3-14-290-9 (BL-62) — 5 Acres

This small artificial pond is part of the Stockwell Ponds system, owned by the Massachusetts Division of Fisheries and Wildlife. The dam is owned by the Division. Informal access to the pond can be gained across the state land. Fishing is permitted.

Singletary Pond #3-14-186-16 (BL-62) — 330 Acres

(See Singletary Pond, Millbury)

Stevens Pond #3-14-290-03 (BL-65) — 85 Acres

This is an artificial, municipally-owned pond. The dam is owned by the town of Sutton. The pond is used for recreation. There is no public access.

Thompson Pond #3-14-290-28 (BL-62) — 8 Acres

Flowage is with the Massachusetts Division of Fisheries and Wildlife. This artificial pond is part of the Stockwell Ponds system. Informal public access is available across the state land. Fishing is permitted.

Town Farm Pond #3-14-290-09.4 (BL-62) — 7 Acres

This artificial pond is under the jurisdiction of the Massachusetts Division of Fisheries and Wildlife, and is part of the Stockwell Ponds system. Fishing is permitted, and informal public access can be gained across this state land. The dam is owned by the Commonwealth, Division of Fisheries and Wildlife.

Welsh Pond #3-14-290-23 (BL-62) — 10 Acres

Flowage is with the Massachusetts Division of Fisheries and Wildlife, as in the rest of the Stockwell Ponds system. This Division has provided informal access to the public waters of this artificial pond for fishing.

11. Upton

Dean Pond #3-14-303-8.1 (BL-66) — 6 Acres

This is an artificial pond contained in the Upton State Forest administered by the Division of Forests and Parks, Department of Environmental Management (DEM). Informal public access to these public waters is available across this state land. Flowage is with the state.

11. Upton (continued)

Lake Wildwood #3-14-303-4 (BL-66) — 35 Acres

This is an artificial municipally-owned lake. Water rights are with the town of Upton. A town beach has been developed. Informal public access to these waters can be gained across this town-owned land.

Mill Pond #3-14-303-5 (BL-66) — 6 Acres

This is an artificial municipally-owned lake. The water rights are owned by the town of Upton. There is no formal public access. The pond is used for recreation.

Pratt Pond #3-14-303-6 (BL-66) — 38 Acres

This is an apparent enlarged natural great pond for which no formal public access has been provided. The flowage is with the town of Upton. A town owned beach and boat ramp have been developed.

12. Uxbridge

Chockalog Pond (BL-64) — 11 Acres

No formal public access has been provided to the waters of this apparent natural great pond.

13. Worcester

Flint Pond #3-14-110-8 (BL-63) — 250 Acres

(See Flint Pond, Grafton)

Green Hill Pond #3-14-348-23 (BL-62) — 25 Acres

This artificial pond is municipally-owned. Flowage is with the city of Worcester, Parks Department. Informal public access to the waters of the pond is presently available across the city-owned parkland.

Indian Lake (North Pond) #3-14-348-21 (BL-62) — 210 Acres

A municipal beach and boat ramp have been developed on this apparent enlarged great pond. The dam is owned by the city of Worcester Parks Department. This Department's policy permits public access across the city-owned parkland.

13. Worcester (continued)

Lake Quinsigamond (BL-63) 781 Acres

The waters of this enlarged natural great pond are controlled by the dam on Flint Pond. The lake has been identified by the Massachusetts Division of Waterways (DEQE). Informal public access can be gained across state land in the Quinsigamond State Park. A state beach, boat mooring, and a municipal boat ramp have been developed. One or more licenses exist from the Division of Waterways to withdraw water from the Quinsigamond Lakes.

Patch Reservoir (BL-61) 35 Acres

This is an artificial, municipally-owned reservoir. Flowage is with the city of Worcester. These municipal waters are open to fishing. The present Worcester Parks policy grants informal public access across the city-owned land.

THAMES STUDY AREA COMMUNITIES

1. Brimfield

Dean Pond #3-7-43-7 (CP-33) 10 Acres

This artificial pond is located in the Brimfield State Forest administered by the Department of Environmental Management, Division of Forests and Parks. The dam is owned by DEM. The pond is used for recreation. A swimming beach has been developed. Informal public access is available across the state land and the pond is stocked by the Massachusetts Division of Fisheries and Wildlife (MDFW).

Dearth Hill Pond #3-7-43-5 (CP-33) 5 Acres

This small artificial pond is located within the Brimfield State Forest under the control of the Division of Forests and Parks. The dam is owned by the state (DEM). Informal access is available across state parkland. The pond is stocked by Massachusetts Division of Fisheries and Wildlife.

East Brimfield Reservoir #3-14-287-8 (TH-1A) 420 Acres

(See East Brimfield Reservoir, Sturbridge)

Green Pond (TH-1A) 5 Acres

This is a small natural pond located on a portion of U.S. Corps of Engineers East Brimfield Reservoir area that is administered by the Massachusetts Division of Forests and Parks (DEM) under license. Informal public access to the pond is available across this state land.

1. Brimfield (continued)

Little Alum Pond #3-7-43-2 (TH-1A) 73 Acres

This is an enlarged great pond, designated by the Division of Waterways (DEQE). The dam and flowage rights are controlled by the Little Alum Lake Association. Formal public access has been established near the outlet by Hampden County.

Pork Barrell Pond (TH-1A) 2 Acres

This small natural pond is located within an area under license to the state on the U.S. Corps of Engineers' East Brimfield Reservoir. Informal public access is available across this state land.

Lost Lake (Gould Pond) (TH-1) 16 Acres

(See Lost Lake, Holland)

Sherman Pond #3-7-43-9 (TH-1A) 86 Acres

This enlarged great pond identified by the Dviision of Waterways (DEQE) has no formal public access. The town of Brimfield controls the dam and flowage rights.

Woodman Pond #3-7-43-6 (CP-33) 8 Acres

This small artificial pond is located within the Brimfield State Forest administered by the Massachusetts Division of Forests and Parks (DEM). This agency controls the dam. There is informal access for swimming across state parkland.

2. Charlton

Blood Pond (TH-1A) 21 Acres

This is an apparent natural great pond with no formal public access.

Buffumville Reservoir #3-14-54-39 (TH-2) 200 Acres

This is an artificial flood control reservoir constructed by the U.S. Corps of Engineers. Access is available to these public waters over this federal land or across a portion under license to the state, the Buffumville State Park. A beach and boat ramp have been developed.

Cranberry Meadow Pond #3-14-280-25 (CP-32) 65 Acres

(See Spencer)

Glenn Echo Lake (Pratt Reservoir) #3-14-52-12 (TH-1A) 112 Acres

This is a municipally-owned artificial pond with no formal public access. The town of Charlton controls the dam and flowage rights.

2. Charlton (continued)

Gore Pond #3-14-80-11 (TH-2) — 169 Acres

(See Dudley)

Granite Reservoir (South Charlton Reservoir, Lake Leland) #3-14-54-34 (TH-2) — 199 Acres

This is a municipally-owned artificial pond with no public access. The dam and flowage rights are controlled by the town of Charlton.

Pierpoint Meadow Pond (TH-2) — 89 Acres

(See Dudley)

3. Dudley

Blood Pond (TH-1A) — 21 Acres

(See Charlton)

Gore Pond #3-14-80-11 (TH-2) — 169 Acres

This is an enlarged great pond designated by the Division of Waterways (DEQE) with no formal public access. A partially breached dam is owned by Stevens Linen Associates, Inc.

Hayden Pond (Mud Hole Pond) #3-14-80-10.1 (TH-2) — 41 Acres

This is an apparent enlarged great pond with no formal public access. The dam and flowage rights are controlled by Stevens Linen Associates, Inc. At present the pond is stocked by Massachusetts Division of Fisheries and Wildlife.

Peter Pond #3-14-80-9 (TH-2) — 44 Acres

This is an apparent enlarged great pond with no formal public access. The Stevens Linen Associates, Inc. controls the dam and flowage rights.

Pierpoint Meadow Pond (TH-2) — 89 Acres

This is an artificial pond with no formal public access. The dam and flowage rights are controlled by the town of Charlton.

4. Holland

Hamilton Reservoir (Holland Reservoir) #3-7-153-3 (TH-1A) — 361 Acres

Informal public access is presently available across town-owned land to the waters of this artificial pond. The dam is owned by the town of Holland. A fisherman's landing has been developed by the town and the reservoir is stocked by the Massachusetts Division of Fisheries and Wildlife. The pond is partly in Connecticut.

Holland Pond (Lake Siog) (TH-1A) — 65 Acres

This apparent natural great pond is within the U.S. Army Corps of Engineers' East Brimfield Reservoir Project. Informal public access can be gained across project land licensed to DEM and known as the Holland Pond Recreation Area. A beach and boat landing has been developed.

Lost Lake (Gould Pond) (TH-1A) — 16 Acres

This is a natural great pond surveyed by the Division of Waterways. Informal access across land licensed by DEM from the Corps of Engineers is available. It is within the Corps-owned East Brimfield Reservoir project.

5. Leicester

Greenville Pond (Greenville Reservoir) #3-14-151-6 (TH-2) — 32 Acres

This is a municipally-owned artificial pond used for water storage. The town of Leicester owns the dam and flowage rights. No formal public access has been established.

Henshaw Pond #3-14-151-15 (TH-2) — 33 Acres

This apparent enlarged great pond is used for water supply. The dam and flowage rights are controlled by the Cherry Hill-Rockdale Water District. No recreational use is presently allowed.

Kettle Brook Reservoir No. 2 #3-14-151-23 (BL-61) — 25 Acres

This is a municipally-owned artificial water supply reservoir with no public access. The city of Worcester controls the dam and flowage rights.

Lynde Brook Reservoir #3-14-151-25 (BL-61) — 125 Acres

This is a municipally-owned artificial reservoir. The dam and flowage rights are controlled by the city of Worcester. Recreational use is not permitted.

5. Leicester (continued)

Shaw Pond #3-14-151-13 (CP-32) 67 Acres

This is an apparent enlarged great pond withdrawn for water supply by the towns of Leicester and Spencer. The town of Spencer controls the dam and flowage rights. The pond is not presently open to recreational use.

6. Oxford

Carbuncle Pond (TH-2) 11 Acres

There is no public access to the waters of this apparent natural great pond presently stocked by Massachusetts Division of Fisheries and Wildlife (MDFW).

Grassy Pond (TH-2) 14 Acres

This is an apparent natural great pond with no formal public access.

Stumpy Pond (TH-2) 7 Acres

This small natural pond is located within the Oxford Wildlife Management Area administered by the Division of Fisheries and Wildlife. Informal public access is available for recreation across the wildlife management area.

7. Southbridge

Westville Pond #3-14-287-19 (TH-1A) 26 Acres

(See Sturbridge)

8. Sturbridge

Alum Pond (Big Alum Pond) #3-14-287-12 (TH-1A) 189 Acres

This is an enlarged great pond surveyed by the Division of Waterways. Formal public access originally acquired by Worcester County is available from a boat ramp maintained by the Massachusetts Public Access Board. The town of Sturbridge owns the dam and flowage rights. It is stocked with fish by Massachusetts Division of Fisheries and Wildlife (MDFW).

Cedar Pond #3-14-287-8 (TH-1A) 158 Acres

This apparent enlarged great pond has no formal public access. The town of Sturbridge controls the dam and flowage rights. Recreation is for local residents only.

8. Sturbridge (continued)

East Brimfield Reservoir #3-14-287-17 (TH-1A) 420 Acres

This is an enlarged great pond raised for flood control purposes. The U.S. Army Corps of Engineers owns the dam and flowage rights. Two boating ramps and a beach have been developed and DEM has a licensing agreement with the Corps for these facilities. The reservoir is stocked by Massachusetts Division of Fisheries and Wildlife (MDFW).

Leadmine Pond (TH-1A) 62 Acres

Here is a natural great pond surveyed by the Division of Waterways (DEQE). Formal public access has been obtained by the county of Worcester. The pond is stocked with fish by Massachusetts Division of Fisheries and Wildlife (MDFW).

Quacumquasit Pond (CP-32) 226 Acres

(See Brookfield)

Walker Pond #3-14-287-7 (TH-1A) 101 Acres

This enlarged great pond has been designated by the Massachusetts Division of Waterways (DEQE). It is located within Wells State Park under the administration of the Division of Forests and Parks (DEM). Public access for recreation is available across the state parkland.

Westville Lake #3-14-287-19 (TH-1A) 26 Acres

This is an artificial flood control reservoir constructed by the U.S. Army Corps of Engineers. A portion of the land in the project is managed under a license from the Corps by the Massachusetts Division of Fisheries and Wildlife. Informal access is available to the public across this state licensed land or the federal land. A boat ramp has been constructed by the Corps.

9. Wales

Lake George #3-7-306-1 (TH-1A) 93 Acres

This enlarged great pond has been designated by the Division of Waterways (DEQE). The town of Wales controls the dam and flowage rights. No formal public access has been obtained.

10. Webster

Webster Lake (Lake Charbunagungamaug) #3-14-316-6 (TH-2) 1195 Acres

This is an apparent enlarged great pond. The dam and flowage rights are owned by Cranston Print Works. The Public Access Board is now developing a boating site which should be available by the Spring of 1978 thus formal public access has been obtained to these waters. The lake is stocked by Massachusetts Division of Fisheries and Wildlife.

APPENDIX D

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